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ABSTRACT

This set of lesson plans is designed for use in teaching vocational agriculture students the correct procedures for operating and maintaining a grain drill. The lesson plan package consists of the following components: (1) a teaching outline that is designed to teach students to understand, operate, lubricate, calibrate, troubleshoot, and store a grain drill; (2) a set of 38 transparency masters designed to reinforce the principles addressed in the teaching outline; and (3) a series of 24 informational and exercise handouts. (MN)

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AGDEX 742

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OPERATING AND MAINTAINING A GRAIN DRILL

Lesson Plans

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OPERATING AND MAINTAINING A GRAIN DRILL

Class _____

Teacher _____

Time _____

Unit Length: 5 days

Performance Objectives: At the end of the unit on grain drills, and when given a specific grain drill, tractor, supplies, measuring equipment, and operator's manual, the students will be able to:

a. Describe either orally or in writing, a "good" job of seeding with a grain drill

b. Explain either orally or in writing the importance of a good job of seeding

c. Use the information in the operator's manual in adjusting, maintaining, repairing, and operating the grain drill

d. Adjust the grain drill for specific seed, fertilizer, and grass seed application

e. Lubricate the grain drill

f. Calibrate the grain drill

g. Operate the grain drill safely and at specific settings

h. Troubleshoot the grain drill and make needed adjustments and repairs

i. Prepare the grain drill for storage

The student will do these at a level of proficiency prescribed by the drill manufacturer as given in the operator's manual and as established by the teacher and students in class discussion.

References: The following references may be used to enhance supervised study.

Operator's manuals for drills being studied which should accompany the drill or may be purchased from the manufacturer.

Brochures from various drill manufacturers which describe their grain drills.

Fundamentals of No-Till Farming, Chapter VIII - "Selecting and Operating No-Till Planters and Drills", AAVIM (available from Ohio Agricultural Education Curriculum Materials Service).

Plant Growth and Development, Ohio Agricultural Education Curriculum Materials Service.

Planting, John Deere and Company (available from Ohio Agricultural Education Curriculum Materials Service).

Current issue of *Agronomy Guide*, Cooperative Extension Service, The Ohio State University (available from Ohio Agricultural Education Curriculum Materials Service).

***Ohio Soils* with yield data and productivity index**, Bulletin 685 (available from Ohio Cooperative Extension Service).

Materials required for study of this unit:

- One or more grain drills with their operator's manuals available in the school shop.
- Hydraulic jack
- Wood blocks
- Paper bags (lunch size)
- Steel tape
- Scales (for measuring in ounces or grams)

I INTRODUCTION

Develop parts A, B, C, D, and E on the chalkboard with the help of the students, using the five leading questions, i.e., A, B, C, D, and E.

A. *Question:* **What is our ultimate goal in crop production?**

To make a profit.

(You may want to review the Summary and Analysis pages of the *Plant Enterprise Record Book* for previous grain crop enterprises to see how some students made a profit. Charts may be made showing the relationships between grain yields, production costs per unit of production, and labor income per unit of production.)

B. *Question:* **What "things" need to occur in order for us to make a profit in producing crops?**

1. Good yields of quality grain.
2. Minimum cost of production.
   (An analysis of production costs for student's field crop enterprises may be found on the "Analysis of the Plant Enterprise" page of the *Plant Enterprise Record Book*.)

   TM 1 ***Potential Yields Possible with Approved Production Practices*** can be made into a transparency or duplicated for distribution to class members. The information may be used to relate how the operation of a grain drill affects one or more of these practices or happenings.

Suggested use of this information:

1. Ask students which type of soil (dark or light) they have on their farms, or the type prevalent in the area.
2. Have students estimate what potential yields are for each type of soil. Write estimates on chalkboard.

   Ohio Extension Bulletin 685 (AGDEX 524), *Ohio Soils with Yield Data and Productivity Index*, 1983, may be used as a reference. (If a copy is not available in your classroom, the County Extension agent or S.C.S. technician may have a copy you can use.)
3. Place the students' estimates in chart form on the chalkboard.

Suggested Chalk Board Chart

Student	Soil Type(s)	Potential Crop Yield		
		Corn	Soybeans	

4. Have students suggest production practices necessary to obtain potential yields.
5. Summarize and condense the students' responses to item 4 into the five items listed on TM 1 and list on the chalkboard. Do not spend a lot of time on summarizing and condensing.
6. Reason out how item 2 on TM 1 relates to the grain drill.

The discussion on question B leads to question C and its development.

C. *Question:* **How important is the efficient operation of our grain drill in reaching this profit goal?**

1. Saves much labor. (At this point, review history of seeding grain, including mechanical seeding of grain by a drill.)

TM 2 ***History of Grain Seeding***

a. Grain first seeded by hand on top of furrowed soil.

b. Grain box on a hoe.

c. Jethro Tull of England in 1731 placed a grain box on wheels and an axle with grain tubes leading down to hoes which tilled the soil.

d. In 1799, the first drill in the U.S.A. invented by Eliakim Spooner.

e. 40 years later, Gibbons of Michigan made a drill with feeding mechanism controlled by speed of drill.

f. In 1842, the Pennock brothers of Pennsylvania built the first successful drill.

g. After 1865, drills were manufactured and sold by the thousands.

2. Saves time and money.

Efficient operation of grain drill will help in getting planting done by proper date.

TM 3 ***Effect of Planting Date on Soybean Yield***

Wheat should be seeded on or within three weeks after the fly-free date (see current *Agronomy Guide).*

3. Does a better job of seeding evenness, uniform depth.

A uniform rate of seeding is necessary for maximum yields.

TM 4 ***A Good Stand of Plants Is Required for High Yields***

For maximum yields soybeans must be planted uniformly at the right seed spacing within narrow rows. (See current *Agronomy Guide* and *Plant Growth and Development*, pages 92-94.)

Due to the tillering characteristics of wheat, the rate and uniformity of seeding wheat is less critical than for soybeans.

D. *Question:* **What are the requirements for seed germination and seedling growth?**

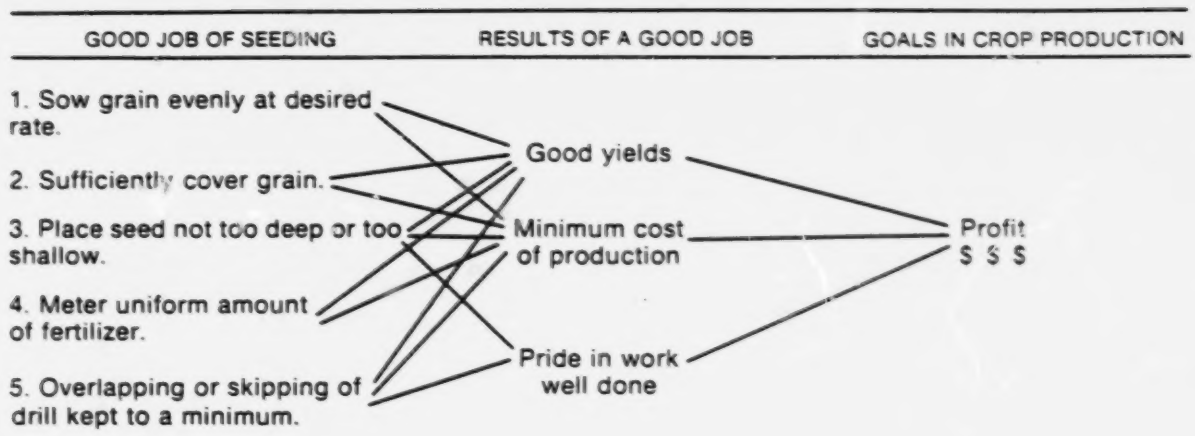
(For more information, refer to *Plant Growth and Development*, pages 1-11.)

TM 5 ***Requirements for Seed Germination***

1. Seed must be in contact with moist soil.
2. Oxygen needed for respiration must be available from air spaces in the soil.
3. The temperature must be favorable for germination.

E. *Question:* **What is the job of the grain drill?**

(Use chalkboard to show relationship among *good job of seeding, results of a good job*, and *how results affect profit goal in crop production.* List the goals of crop production and then, working from left to right, develop the description of a good job of seeding and then the results of a good job of seeding. Use connecting lines to show relationships.)


GOOD JOB OF SEEDING
RESULTS OF A GOOD JOB
GOALS IN CROP PRODUCTION
1. Sow grain evenly at desired rate.
2. Sufficiently cover grain.
3. Place seed not too deep or too shallow.
4. Meter uniform amount of fertilizer.
5. Overlapping or skipping of drill kept to a minimum.
Good yields
Minimum cost of production
Pride in work well done
Profit
$ $ $

The following transparency masters may be made into transparencies or duplicated for a handout to assist in developing the **good job of seeding** part of the relationship along with the **results of a good job** and the **goals in crop production.** These transparency masters are from the series *Plant Growth and Development*. The page numbers given refer to the pages in the student manual *Plant Growth and Development* and may be referred to if more in-depth teaching is desired.

TM 6 ***Plant Seeds at the Right Depth*** pages 25-26

TM 7 ***Seed Size Should Determine Planting Depth*** page 26

TM 8 ***Wheat Germination and Seedling Growth*** page 7

TM 9 ***Soybean Germination and Seedling Growth*** page 8

II IDENTIFYING PROBLEMS

Question: **What problems have we encountered with our grain drills that would prevent us from doing a good job of seeding?**

Student answers will probably range from general problems — "It won't plant" — to specific problems such as "Power shaft doesn't run." All answers can be listed on the chalkboard because the degree of specificity does not affect the answers needed for the question in section III.

Possible student answers:

A. Clogged boot holes.
B. Seed not covered at same depth.
C. Fertilizer box and devices not working.
D. Broken parts.
E. Uneven seeding.
F. Inaccurate amount of seed sown.
G. Seeding mechanism doesn't sow same amount of seed.
H. Power shaft doesn't engage or run.
I. Drill won't plant.
J. Fertilizer or seed feeding units "frozen" and drive shaft won't turn.
K. Soybean seed damaged by feeding units.
L.

III BASIC KNOWLEDGE REQUIRED TO SOLVE AND/OR PREVENT PROBLEMS

Question: **What do we need to know in order to solve and/or prevent these problems?**

Possible student answers: (Place on chalkboard)

A. Know types of drills.
B. Know how a drill does its job.
C. Know names of parts and what they do.
D. Know how to set adjustments.
E. Know what tools are needed to maintain, adjust, or repair drills.
F. Know how to set drill to do what you want it to do.
G. Know how to operate the drill safely.
H. Know how to lubricate the drill.
I. Know how to prepare the drill for storage when not in use.
J.
K.

IV RELATED INFORMATION ON WHAT WE NEED TO KNOW

Information can come from supervised study periods. Tasks listed in section III as "needed to know" should be taught in appropriate sequence as decided by the teacher. (Suggested reference: *Planting*, John Deere, available from Ohio Agricultural Education Curriculum Materials Service. Section on "Grain Drills," pages 99—131. Also manufacturers' operator's manuals and promotional brochures may be used to illustrate different drill features.)

A. Types of Drills

(Use manufacturers' brochures to illustrate the different types of drills.)

1. *End Wheel Drive.* Suitable for normal or moist soil conditions. The wheels at the end of the drill both drive the drill mechanisms and carry the weight of the drill.

   TM 10 ***End Wheel Drive Drill***

2. *Press Wheel Drive.* Suitable for dry conditions. The press wheels at the rear of the drill firm the soil over the seed, drive the drill mechanisms, and carry the weight of the rear of the drill. A yoke wheel is used to carry the front of the drill.

   TM 11 ***Press Wheel Drive Drill***

3. *Front Mounted Wheel Drive.* These drills are driven by wheels mounted in front of the drill. It is claimed that the driving mechanism operates in a more dirt-free location. The transparency masters show some of the designs.

   a. *Front Mounted Gauge Wheel Drive.* (Some models may be spring loaded.)

      TM 12 ***Front Mounted Gauge Wheel Drive Drill***

   b. *Front Mounted, Spring Loaded Wheel Drive.*

      TM 13 ***Front Mounted, Spring Loaded Wheel Drive Drill***

   c. *No-Till Drill Attachment*

      TM 14 ***Front Mounted, Spring Loaded Wheel Drive Drill with No-Till Attachment***

      Fluted or ripple-style coulters are mounted to run directly in front of the furrow openers to prepare a seedbed and cut through plant residue.

TM 15 *No-Till Coulters*

In no-till seeding **fluted** coulters may be used to till the soil ahead of the furrow openers. The amount of fluting on the coulter can vary from wavy and wide-fluted to narrow or **ripple** style. Wavy fluted coulters may throw soil in some situations.

Since weight has more to do with penetration than any other factor, most no-till drills are heavier in construction to carry the extra weight when needed. Most will use double disk furrow openers with press wheels for covering and firming soil around the seed.

4. *Type of Hitch*

   a. *Pull-type Drill* with a tongue for hitching to the tractor drawbar. The hitch yoke and clevis are adjustable up and down to aid in leveling the drill.

   b. *3-point Hitch Drill* that may be lifted from the ground.

   c. *No-Till Hitch* that hitches to the tractor with a 3-point hitch drill being attached to the no-till attachment.

   d. *Secondary Tillage Hitch* that hitches to the tractor to perform secondary tillage operations. The drill is hitched to the secondary tillage hitch.

   e. *Multiple Hitch* arrangements to pull more than one drill.

   f. Some drill models can be converted from a 3-point hitch to a pull-type hitch by the use of a two-wheel caddy to which the drill is attached.

   g. Lift-assist wheels may be used with a small tractor to carry part of the weight of a 3-point hitch drill.

B. **Parts of the Grain Drill**

Suggestions for teaching: The teacher can place names of parts on 3" x 5" cards. Students can draw a card or cards from the "deck". Using the operator's manual or reference books and brochures, the students locate their selected drill part and determine the function of the part. When the students are sure they can locate their assigned parts, they tape the cards on the correct parts of the drill. After locating the assigned part, the student returns to the operator's manual or reference book and determines the function of the part. When all cards are posted, the teacher directs each student to name the assigned part and explain its function in the operation of the grain drill.

The teacher might wish to reproduce **Form 1** PARTS OF THE GRAIN DRILL and distribute it to the students for their use in studying grain drill parts. If the aforementioned card procedure is used, the students will fill out their section completely. The remaining students would complete their forms as the student reports are being made.

C. **Seed Feeding Mechanisms**

The transparency masters and pictures in operator's manuals and brochures may be used to illustrate the different feeding mechanisms.

1. *Fluted Feed Unit.* The most popular type of feeding mechanism. One unit for each furrow opener is attached to the bottom of the seed hopper. All the units are on a common feed shaft. Not all drills have each of the features listed below.

   TM 16 *Fluted Feed Unit*

   a. *Feed run cup.* Grain from the grain box falls into the feed run cup.

   b. *Fluted wheel* which runs inside the feed run cup.

   c. *Cutoff*

   d. *Adjustable feed gate*

e. *Feed gate lever* with three positions:

1) Narrow position for small grains and similar sized seeds.
2) Middle position for small soybeans and similar sized seeds.
3) Wide position for large soybeans and similar sized seeds.

The rate of seeding is changed by:

1) Moving the grain feed shifting lever which moves the fluted wheel into and out of the feed run cup exposing more or less of the feed roll to the seed in the feed run cup.

2) Changing the speed of the fluted feed wheel drive shaft.

TM 17 ***Changing Rate of Seeding — Fluted Feed Drills***

TM 18 ***Plain Grain Fluted-Feed Drive Train***

2. *Double-run feed unit*

TM 19 ***Double-run Feed Unit***

Good for use with small seeds at low rates. Will also meter large seeds at any desired rate. One unit for each furrow opener is attached to the bottom of the seed hopper. All the units are on a common feed shaft.

a. *Feed run cup.* Grain from grain box falls into the feed run cup. Inside this cup is the feed gate regulating the size of the feed opening to determine the rate of seeding. A feed gate is located on each side of the feed wheel.

b. *Feed wheel.* Each side of the wheel has ribs which carry the seed as the wheel turns. The seed is delivered at a metered rate into the seed tube. One side of the wheel has a large number of small ribs or scallops for small seeds, while the other side of the wheel has a smaller number of larger ribs or scallops for larger seeds. Thus the seeding mechanism is called *double-run.*

c. *Feed cover.* The feed cover is used to block off the side of the double-run feed wheel not being used.

d. *Feed gate lever.* One is located on each side of the feed run cup and controls the adjustable feed gate on its respective side. A series of notches for each lever indicates the different settings.

The rate of setting is changed by:

1) Using the feed cover to block off the large seed or small seed side of the feed wheel.

2) Placing the feed gate lever on the side of the feed wheel being used in the appropriate notch.

3) Changing the speed of the feed wheel drive shaft.

TM 20 ***Plain Grain Double-Run Feed Drive Train***

D. **Fertilizer Metering Systems**

The transparency masters, pictures in operator's manuals, and brochures may be used to illustrate the different types of fertilizer attachments and metering systems.

The drill box may be divided with one side holding seed and the other side holding fertilizer. Some fertilizer attachments will have a separate box for fertilizer attached to the seed box.

TM 21 ***Combination Seed and Fertilizer Box***

FERTILIZER METERING TYPES

1. *Feed Rolls* - These rolls, located on a fertilizer feed shaft, deliver fertilizer into the delivery tubes.

TM 22 ***Grain and Fertilizer Fluted-Feed Drive***

A break-out of the power train shows how each part of the drill is driven. Included on this transparency master are also enlargements of one of the fertilizer feed wheels and the gears inside the gear box.

a. Rate of fertilizer application is determined by the speed of the fertilizer feed shaft on which the feed rolls are located. The feed shaft speed may be changed by:

1) shifting the gear case and/or

2) changing drive sprocket combinations

2. *Star Wheel* — Star wheels are located above the fertilizer feed shaft and are rotated by bevel gears. The star wheels rotate and deliver the fertilizer through an adjustable feed gate and into the delivery tubes.

TM 23 ***Star Wheel Fertilizer Metering System***

a. Rate of fertilizer application is determined by:

1) speed of the star wheel rotation and

2) the adjustable gate setting

b. Safety shear pins are used to protect the star feed wheels.

3. *Wire Worm* - A rotating wire coiled around the fertilizer drive shaft delivers the fertilizer to the fertilizer delivery tube opening. Rate of application is determined by the speed of the wire worm.

TM 24 ***Wire Worm Fertilizer Metering System***

a. Rate of fertilizer application is determined by:

1) the arrangement of the drive gears and/or

2) the adjustment of the variable-speed V belt pulley.

E. **Grass Seed Attachment**

The grass seed attachment may be attached to the front or rear of the grain drill. (TM 11 shows front attachment.)

1. A *fluted* or *double-run feed seeding mechanism* may be used similar to grain feeding units with the fluted feed being most common.

TM 25 ***Grass Seed Attachment***

2. *Band seeding attachment*
Brackets or spring steel rods are available to hold the ends of the grass seeding tubes in position to place the seed in bands over the sown grain and fertilizer.

TM 26 ***Band Seeding Attachment***

(Reference: "Forages" section of the current issue of the *Ohio Agronomy Guide*)

3. The *grass seed attachment* may be used to apply insecticides and herbicides.

F. **Furrow Openers**

Furrow openers open the soil surface and place the seed at the desired depth. The soil falls into the opening behind the opener, covering the seed.

TM 27 ***Furrow Openers***

Two types of furrow openers:

1. *Disk type*

   a. *Single disk* openers for hard or trashy soil conditions. The seed is guided into the soil through a delivery boot. Scrapers are optional.

   b. *Double disk* openers for well-prepared seed beds and for use where a higher speed of planting is desired. Soil throw is less than with the single disk at higher speeds. Scrapers are optional.

2. *Shovel* openers for extra hard or stony soil. Automatic trips let the shovel ride over objects such as large rocks, then return to its working position.

   Furrow openers are pulled and guided by drawbars which are attached to the drill frame. Each drawbar moves independently. (Point out the furrow openers on a grain drill, or use photos in manuals and brochures, go to an implement dealer, and use the transparency masters.)

G. **Tractor Tire Track Remover**

Shovels are mounted in the drill frame ahead of the openers and following the tractor wheels. Their purpose is to loosen the ground that has been packed by the tractor wheels to provide for more accurate seed planting depth across the length of the drill.

TM 28 ***Tractor Tire Track Remover***

H. **Acreage Counter**

The function of the acreage counter is to indicate the number of acres that have been seeded. Some acreage counters can be adjusted for different field conditions and tire sizes. May be standard or optional equipment on drills.

TM 29 ***Acreage Counter***

I. **Marker**

Markers may be used to help prevent skipping or overlapping of rows. They may have a manual or a hydraulic lift. They may be left-hand only or both right- and left-hand markers.

J. **Multiluber**

A multiluber unit is an attachment that lubricates all lubrication points at one time. The unit saves time in lubricating the drill and eliminates the possibility of missing some grease fittings.

K. **Multiple Hitch**

Multiple hitch units provide for hitching two or more drills together.

L. **Seed Covering and Firming**

For germination to take place, the seed must be in contact with warm moist soil. (You may want to review TM 5.)

The following devices are used for seed covering and firming.

TM 30 ***Seed Covering and Firming Devices***

1. End wheel type drills

   a. *Covering chains* will adequately cover the seed when the soil is moist and loose.

   b. *Press wheels* may be used to cover the seed and firm the soil over the seed when the soil is loose and dry, or for minimum till operations.

   c. Some furrow openers may be designed to cover the seed *without additional attachments.*

2. Press wheel type drills

   A variety of press wheel types is available for the press wheel drill. (See manufacturer's brochures for examples.)

M. **Lifting Mechanisms**

The seeding units must be raised for transportation, backing, and making sharp turns with the drill.

TM 31 *Lifting Mechanisms*

There are three types of lifting mechanisms. They attach to the furrow opener drawbar and raise or lower it as desired. The lifting mechanisms can be set for depth adjustments. The three types are:

1. *Hand lever lift* - One is located on each side of the drill and each lever must be operated separately.

2. *Mechanical power lift* - The power supplied by the drive wheels is used in raising the furrow opener drawbars. Trip ropes are used to engage or disengage the mechanical lifts. One is located on each side of the drill.

3. *Hydraulic power lift* - A hydraulic cylinder is used to raise the furrow opener drawbars. A hydraulic control valve is mounted on the tractor for the operator to use in raising and lowering the furrow opener drawbar assemblies and to adjust the depth of planting.

V OPERATING THE GRAIN DRILL

A. **Introduction - What Was Accomplished**

The study of grain drills was introduced by identifying the following:

- The goals of crop production and some things that must be done to accomplish the goal.
- Some problems students have encountered in using the grain drill.
- Identifying what students should know and be able to do concerning the grain drill.

The first step in answering the above concerns was to identify the major parts of the grain drill and to describe their functions. The students should now be ready to consider the operation of the grain drill. A problem statement similar to the following might be placed on the chalkboard.

B. *Question:* **How can I prepare my grain drill for operation in order to obtain the best possible seeding job?**

Have the students describe the field conditions under which their drills will be operating. Place survey on chalkboard as it is developed with the class.

The seed bed may be well or poorly prepared. Some form of minimum tillage or no-tillage may be practiced.

Student	Crop	Season	Tillage Practice

Question: **What preparations should be made before drilling?**

a. Preparing the tractor (see operator's manual)

1) Service tractor for top performance.
2) Prepare the tractor for hitching of the grain drill as specified in the tractor or grain drill operator's manual.

b. Preparing the grain drill (see operator's manual)

1) Inspect grain, fertilizer, and grass seed compartments and remove any grain or foreign objects that might cause damage.
2) Check the operation of all drive mechanisms by turning the drive shafts with a wrench as recommended in the operator's manual.

TM 32 ***Rotating Drive Shafts***

Turn grain and grass feed shafts in direction of travel. Turn fertilizer feed shaft in reverse of direction of travel. If shaft refuses to turn, rock back and forth to free, but do not force. If rocking does not free the drive shaft, take the feeding mechanisms apart and clean. Use kerosene, diesel fuel, or other cleaning fluid. (**Caution:** Observe all safety practices (page 19, 3f) when using combustible fluids.) Keep cleaner or water out of furrow openers.

3) Check all feeding units (grain, fertilizer, and grass) to see if they are all set the same. If the feeding units are not all the same, refer to the operator's manual to determine how they should be reset.
4) Check and tighten all loose nuts to the torque values specified in the torque charts in the operator's manual.
5) Check and spread all cotter pins.
6) Check the alignment of all drive chains and sprockets. Chains must be adjusted so that they run straight with the proper amount of tension.
7) Check disk blades to see if they turn freely, are in good condition, and have good bearings.
8) Check tire inflation. The drill is designed to operate with the specified tire size and inflation pressure.

Question: **What effect will *under-inflation* have on:**

- **the rate of seeding?** Under-inflation will increase the rate of seeding because wheels will turn more times in traveling a given distance.

- **tire wear?** Under-inflation may cause the tire to slip on the rim, which can result in tearing off the valve stem, buckling the side walls, fabric breaks, and uneven tire wear.

Question: **What effect will *over-inflation* have on:**

- **the rate of seeding?** Over-inflation will decrease the rate of seeding because wheels will turn less times in traveling a given distance.

- **tire wear?** Over-inflation may cause excessive tire wear and increased wheel slippage; tires may sink deeper into soft soil.

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9) Lubricate the grain drill.

Using a grain drill in the shop or other location, assign a team of students to locate all places requiring lubrication. The team should use the operator's manual to determine the location of all places requiring lubrication and to identify the specifications of the lubricant to use and the lubrication schedule (daily, annually, and in preparation for storage).

The team of students can report their findings to the remainder of the class and demonstrate the proper way of applying lubrication.

Form 2 LUBRICATING THE GRAIN DRILL may be reproduced for the team to use in preparing their report.

Question: **What is the purpose of lubricating machinery?**

The lubricant forms a protective film between two moving surfaces which reduces wear. The lubricant also keeps dirt from getting into the moving parts.

Question: **What would happen if grease fittings were not cleaned before using grease gun and if dirt were forced into the bearing?**

The dirt and lubricant would mix to form a kind of grinding compound that could cause excessive wear.

Question: **What would probably happen if you failed to locate one or more of the grease fittings?**

The bearing(s) would wear out quickly and require expensive repair, stopping the drill when it might be needed for timely planting.

10) Make initial adjustments on the drill for the crop being planted by following the recommendations in the operator's manual.

This prompts the next question that may be placed on the chalkboard.

C. *Question:* **How should I initially adjust the grain drill for the desired rate of seed and fertilizer application per acre?**

It will be necessary to have the operator's manual available for each grain drill being studied.

Form 3 ADJUSTING GRAIN DRILL FOR RATE OF SEEDING AND FERTILIZER APPLICATION may be used by students along with the operator's manual to determine initial settings.

1. *HITCHING*

For efficient operation the drill should be level when on a level surface. Check your operator's manual for specific instructions.

TM 33 ***Hitching Drill in Level Position***

Question: **How would the drill operation be affected if the drill were not approximately level?**

- Furrow openers would not have correct penetration.
- Depth of seeding would not be uniform.
- Increased wear on furrow openers would result.

Drills equipped with gauge wheels or drive wheels in front of the drill may have provisions for raising or lowering the wheels depending upon soil conditions. Check the operator's manual for drills so equipped.

2. *ADJUSTMENT FOR RATE OF SEEDING GRAIN*

Question: **How should _____ set his/her grain drill for desired seeding rate before starting to plant?**

Grain drill operator's manuals have grain seeding charts to use as a guide for setting feeding units for desired seeding rates. Some drills may also have a grain seeding chart located on the inside of the drill box lid. *Seed metering devices are designed to measure* ***volume*** *rather than weight or to meter out individual seeds.*

Question: **What are the factors that affect the number of seeds planted per acre or per foot of row?**

Possible answers:

1) The seed metering mechanism will measure more small seeds than large seeds per foot of row at a given setting.

   Teacher tip: Have two sample bottles of the same size: — one filled with large seed soybeans and the other filled with small seed soybeans. Have students compare the number of seeds in each bottle.

2) Seeds with different moisture content may meter at different rates.

3) Seeds that have been treated with inoculant or a pesticide may meter at different rates than untreated seeds.

4) Tire pressure and tire size will affect the speed of the seed metering device.

5) Some soil conditions encourage wheel slippage which affects the speed of the seed metering device. The load in the drill and speed can also affect wheel slippage.

Conclusion: The grain seeding rate charts are based upon clean seed of average quality and U.S. standard weight per bushel. Since your seed will probably be somewhat different, the rate of seeding would not be the same as indicated on the chart. The charts are intended to be used only as a starting point in setting the rate of seeding.

TM 37 ***Which Test Weight Has the Greater Volume?***

Wheat with a low test weight per bushel will have more volume for a given weight than wheat with a high test weight.

Question: **What effect will test weight per bushel have on the rate of metering seed?**

Now is the time to apply the knowledge gained while studying the parts of the drill and their functions. Not all makes and models of grain drills work in the same way, so you must depend upon your operator's manual to determine how your drill should be adjusted.

a. Setting drills with fluted feeds

   1) Set fluted wheel to increase or decrease the opening size to let through more or less seed. Check the operator's manual to determine how this adjustment is made for your drill by . . .

      - moving a grain shifter lever, or
      - making the adjustment at the end of the seeder drive shaft.

   2) Set feed gates in proper position for seed being drilled. See operator's manual for proper setting. Not all drills have feed gates.

   3) Adjust feed shaft speed by changing gears, sprockets or pulleys to change the speed of the feeding unit. See the operator's manual for recommended settings.

      Question: **What is the relationship between feed shaft speed and the fluted feed opening size?**

      For a given fluted feed setting the rate of seeding will be approximately doubled if the feed shaft speed is doubled.

b. Setting drills with double-run feeds

   1) Position feed cover over the side of the feed cup wheel not being used. (One side is for large seeds and the other for small seeds.) See the operator's manual.

   2) Position the feed gate lever in the proper notch on the side of the wheel being used. See the operator's manual for recommended setting.

   3) Adjust feed shaft speed by changing gears, sprockets, or pulleys to change the speed of the feeding unit.

3. *ADJUSTMENT FOR RATE OF FERTILIZER APPLICATION*

Question: **How should _____ set his/her grain drill to apply the desired amount of fertilizer?**

If the drill box has a divider, position the divider to hold the desired amount of fertilizer.

Grain drill operator's manuals have fertilizer charts (similar to grain seeding charts) to indicate settings for desired rates of fertilizer application. Different fertilizer materials have different bulk densities. Bulk density may be measured in pounds per cubic foot (or kilograms per cubic decimeter).

Question: **At a given drill setting, would a fertilizer with a heavy bulk density of 70 pounds per cubic foot drill *more* or *less* pounds per acre than a fertilizer with a lighter bulk density of 50 pounds per cubic foot?**

The lighter bulk density fertilizer will drill less pounds per acre at a given setting than the heavier bulk density fertilizer.

Suggested student exercise:

Some implement dealers and fertilizer dealers have bulk density meters that they might demonstrate in their place of business or loan to you for use in your classroom.

The fertilizer application charts are designed for fertilizer with a specific bulk density. The settings for heavier or lighter fertilizers must be adjusted if the desired amount of fertilizer is to be applied. Some grain drill operator's manuals provide for this adjustment. A sample page from a John Deere Operator's Manual follows on page 14.

a. Setting drills with fertilizer feed rolls

1) Using the fertilizer rate chart, set the fertilizer feed shaft speed by changing the drive gears, sprockets, or pulleys for the recommended speed.

2) Shift the gear box to the recommended setting to further increase or decrease the speed of the feed rolls.

b. Setting drills with fertilizer star wheel feeding units

1) Check the setting of the fertilizer gate.

2) Using the fertilizer rate chart, select the recommended speed for the fertilizer drive shaft.

c. Setting drills with wire worm fertilizer feeding units

1) Using the fertilizer rate chart, set the fertilizer feed shaft speed by changing the drive gears, sprockets, or pulleys for the recommended speed.

4. *ADJUSTMENT FOR RATE OF PLANTING GRASS SEED*

Question: **How should _____ set his/her grain drill to apply the desired amount of grass seed per acre?**

Grain drill operator's manuals have grass seed rate-of-sowing charts similar to the grain seeding charts. These charts are for average seeds and only give an indication of how to set the grass seed attachment for a trial run.

a. Setting rate of grass seed application

1) Set speed of grass seed metering device drive shaft by selecting gear, sprocket, or pulley combinations. See the operator's manual for specific instructions.

2) Adjust the size of the seed metering device opening . . .
- using shift lever or
- adjusting wheel at end of drive shaft.

b. Using band seeding attachments for forage crops

DENSITY METER

Density lbs/cu. ft. (kg/cu. dm.)	Conversion Factor
45 (0.72)	1.45
50 (0.80)	1.30
55 (0.88)	1.20
60 (0.96)	1.10
65 (1.04)	1.00
70 (1.12)	0.93
75 (1.20)	0.87
80 (1.28)	0.81

Fertilizer Charts

IMPORTANT: The rates shown on the charts are to be used only as a guide.

1. Rates are based on fertilizer having a density of 65 pounds per cubic foot. (1.04 kilograms per cubic decimeter).
2. Use density meter (illustrated) available from your dealer to determine density, or contact fertilizer dealer. Nitrogen fertilizers generally weigh less than high potash or phosphorus fertilizers. Fill meter's bucket with material, tap lightly, level material with top, balance on knife edge and take reading.
3. Use conversion chart for other densities.

   Example: To apply 100 lb/acre (112 kg/hectare) with a density of 45 lb/cu ft (0.72 kg/cu dm) multiply 100 (112) by conversion factor — 1.45. Answer: 145 lb/acre (162 kg/hectare). Locate 145 (162) in the fertilizer charts for your row spacing, then set the gear case speed selectors. For this example, with 7-inch (0.18-m) row spacing, set the gear case selectors in E5 and the feed shaft speed in Drive 1.

		POUNDS PER ACRE (KILOGRAMS PER HECTARE) FOR DRILLS IN DRIVE 1 *																				
Gear Case Setting		A1	B1	A2	C1	B2	A3	D1	C2	B3	A4	C3*	B5	C4	D3	E2	C5	D4	E3	D5	E4	E5
Row Spacing	6-INCH	44	50	55	58	63	66	70	73	75	77	86	100	102	105	109	117	123	131	140	153	175
	(152 mm)	(49)	(56)	(62)	(65)	(71)	(74)	(78)	(82)	(84)	(86)	(96)	(112)	(114)	(118)	(122)	(131)	(138)	(147)	(157)	(171)	(196)
	7-INCH	36	43	47	50	54	56	60	63	64	66	75	86	88	90	94	100	106	113	120	131	150
	(178 mm)	(43)	(48)	(53)	(56)	(61)	(63)	(67)	(71)	(72)	(74)	(84)	(96)	(99)	(101)	(105)	(112)	(118)	(127)	(135)	(147)	(168)
	8-INCH	33	38	41	44	47	50	53	55	56	58	66	75	77	79	82	88	92	99	106	115	132
	(203 mm)	(37)	(43)	(46)	(49)	(53)	(56)	(59)	(62)	(63)	(65)	(74)	(84)	(86)	(89)	(92)	(99)	(103)	(111)	(119)	(129)	(148)
	10-INCH	26	30	33	35	38	40	42	44	45	46	53	60	61	63	66	70	74	79	84	92	105
	(254 mm)	(29)	(34)	(37)	(39)	(43)	(45)	(47)	(49)	(50)	(52)	(59)	(67)	(68)	(71)	(74)	(78)	(83)	(89)	(94)	(103)	(118)

*C3 setting is identical to A5, B4, D2, and E1 (not shown)

		POUNDS PER ACRE (KILOGRAMS PER HECTARE) FOR DRILLS IN DRIVE 2																				
Gear Case Setting		A1	B1	A2	C1	B2	A3	D1	C2	B3	A4	C3*	B5	C4	D3	E2	C5	D4	E3	D5	E4	E5
Row Spacing	6-INCH	142	162	177	189	203	213	227	236	243	248	283	324	331	340	365	378	397	426	454	497	568
	(152 mm)	(159)	(182)	(199)	(212)	(228)	(239)	(254)	(265)	(272)	(278)	(317)	(363)	(371)	(381)	(396)	(434)	(445)	(477)	(509)	(557)	(637)
	7-INCH	122	139	152	162	174	182	195	203	208	213	243	278	284	292	304	324	340	365	389	426	486
	(178 mm)	(137)	(156)	(170)	(182)	(195)	(204)	(219)	(228)	(233)	(239)	(272)	(312)	(318)	(327)	(341)	(363)	(381)	(409)	(436)	(477)	(545)
	8-INCH	106	122	133	142	152	160	170	177	182	186	213	243	248	255	266	284	298	319	341	372	426
	(203 mm)	(119)	(137)	(149)	(159)	(170)	(179)	(191)	(198)	(204)	(208)	(239)	(272)	(278)	(286)	(298)	(318)	(334)	(358)	(382)	(417)	(477)
	10-INCH	85	97	106	114	121	128	136	142	146	149	170	195	199	204	213	227	238	255	272	298	340
	(254 mm)	(95)	(109)	(119)	(128)	(136)	(143)	(152)	(159)	(164)	(167)	(191)	(219)	(223)	(229)	(239)	(254)	(267)	(286)	(305)	(334)	(381)

*C3 setting is identical to A5, B4, D2, and E1 (not shown)

(John Deere)

To determine the recommended procedures for band seeding of forage crops, follow the instructions in the *Agronomy Guide* published by the Department of Agronomy, The Ohio State University and available from the Curriculum Materials Service.

Review TM 26 *Band Seeding Attachment.*

Many drill manufacturers have band seeding attachments available. Sometimes producers choose to build their own band seeding attachments.

5. *ROW CROP OR SKIP ROW SEEDING*

Sometimes it is desirable to use the grain drill in seeding row crops or for skip-row planting. See the *Agronomy Guide* for more information.

Question: **How can _____ set his/her grain drill to seed row crops or for skip row seeding?**

Drill manufacturers provide caps to cover the grain and fertilizer feed cups that are not going to be used.

Furrow openers that are not used do not have to be removed. They may be left in the down position to till the soil or may be tied up to prevent unnecessary wear.

Some drill manufacturers may recommend removing the unused fertilizer feed wheels or star wheels to prevent wear by fertilizer trapped in the feed cup.

The rate of seeding must be adjusted for the wider row spacing. See the *Agronomy Guide* for specific recommendations.

To obtain proper drill settings for row-crop planting, multiply the amount per acre (hectare) to be planted by one of the conversion factors for the row spacing indicated. Apply this amount to the rate charts to obtain feed index, sprocket and gear combinations for drives, and fertilizer gear case settings.

FEED CUP SPACING in. (mm)	ROW CROP SPACING inches (mm)					
6 (152)	12 (305)	18 (457)	24 (610)	30 (762)	36 (914)	
7 (178)	14 (356)	21 (533)	28 (711)	35 (889)	42 (1066)	
8 (203)	16 (406)	24 (533)	32 (813)	40 (1016)		
10 (254)	20 (508)	30 (762)	40 (1016)			
CONVERSION FACTOR	2	3	4	5	6	

(John Deere)

Example: To plant 50 pounds (56 kilograms) of soybeans in 30-inch (762-mm) rows with a fluted feed drill with 6-inch (152-mm) feed cup spacing, multiply 50 (56) x conversion factor of 5 = 250 lb (280 kg) per acre (hectare).

Refer to the particular rate chart to find the closest setting for 250 lb/acre (280 kg/hectare).

For a row spacing not shown in the conversion chart, use the formula as shown.

$$\frac{\text{Row Crop Spacing}}{\text{Feed Cup Spacing}} = \text{Conversion Factor}$$

Example: To plant 42-inch (1064-mm) rows with a drill that has 6-inch (152-mm) spaced feed cups, divide the row crop spacing by feed cup spacing to obtain the conversion factor of 7.

D. **Grain Drill Calibration**

Question: **How can _____ be sure that his/her grain drill is seeding the desired amount of seed/fertilizer/grass seed** (select appropriate one) **per acre?**

The calibration of the grain drill is essential to obtain the desired seeding rate per acre because of the type of seed metering mechanism used. Seeding rate charts found in operator's manuals and on the grain drill hopper lid show the seeding rate in pounds per acre. However, the seed metering mechanism on a grain drill *meters seed by volume rather than by weight*. Therefore, the pounds per acre of seed can vary tremendously because the weight per seed, size of seed, amount of foreign material in the seed, etc. vary with different varieties, brands, and types of seed.

TM 38 ***Importance of Checking Quantities Drilled***

Two equal volumes of seed (1 bushel) can vary by 20 pounds in weight. Thus a grain drill that has *not* been calibrated would seed at two different rates in pounds per acre while metering the same volume of seed. In order to obtain the desired seeding rate in pounds per acre, you must calibrate your grain drill before using it and again when changing varieties, brands, or types of seeds. A suggested calibration procedure is given in Form 4.

For assistance in calibrating the grain drill, see the following forms:

Form 4 LABORATORY EXERCISE — GRAIN DRILL CALIBRATION

For materials needed for calibrating the grain drill see the introduction.

Form 5 GRAIN DRILL FEED CUP DISTRIBUTION GRAPH

Form 6 FIELD EXERCISE — GRAIN DRILL CALIBRATION

E. *Question:* **How can I set the grain drill to achieve the desired *depth* of seeding?**

To meet the requirements for germination, seeds must be placed in contact with warm moist soil. While seeds must be covered to germinate and emerge, the seedlings will not emerge if placed too deep.

Review TMs 5, 6, 7, 8, and 9.

The various pressure devices on a grain drill such as pressure springs and hydraulic cylinders do not always maintain a uniform depth of seeding and seed covering under varying soil conditions.

No-till drills are constructed with enough weight or they provide for the addition of extra weight which can force the furrow openers to the desired depth.

Due to the different soil types, soil conditions, methods of tillage, seeds being sown, and soil moisture content, the depth of seeding must be adjusted with the drill operating in the field where the planting is being done.

Form 7 ADJUSTING GRAIN DRILL FOR DEPTH OF SEEDING may assist students in using the operator's manual to learn how to set the desired depth of seeding on their grain drills.

1. Is the grain drill heavy enough to force the furrow openers into the ground? Are the furrow openers sturdy enough to withstand the pressure required to keep them in the ground?
2. Some grain drills provide for moving the drive wheels up or down to assist in achieving desired depth of seeding under different soil conditions.
3. Gauge wheel adjustment on drills using gauge wheels for a part of the depth adjustment.
4. Maintain down pressure on furrow opener pressure rods by adjusting the spring compression.

TM 34 ***Pressure Spring Adjustment***

5. Depth limiting devices

   a. Depth control press wheel attached to the furrow opener drawbar. May be adjusted up or down to regulate depth of seeding.

   b. Depth bands on furrow opener disk limit the depth to which the furrow opener may penetrate.

   c. Seed firming press wheel - no depth control.

   d. Lateral depth control wheel at side of furrow openers.

   TM 35 ***Depth Limiting Devices***

6. Minimum till attachments

   TM 36 ***Minimum Till Attachment***

   Review TM 15, two types of *No-Till Coulters.*

   Question: **How should the minimum tillage attachment be adjusted?**

   a. Drill should be at the proper height and level.

   b. Adjust pressure springs until correct depth is reached.

      - Coulters should cut through trash.
      - Coulters should not run deeper than seed is placed or the seed may be planted too deep.

   c. Add weight if required to bring about desired penetration.

   d. Ground preparation

      - Crop residue should be uniformly distributed.
      - Ground should be relatively smooth in contour and free of large clods or ruts. Ground height variation of more than 4" to 8" across the width of the drill will cause uneven down pressure by the springs.
      - When possible, plant in moist (not muddy) soils. Soils with higher moisture content have considerably less shear strengths than dry soils. Many penetration problems can be avoided by planting at the proper moisture content.

7. Checking grain drill performance

   Question: **How can I know when my drill is doing a good job of seeding?**

   Many drills will not place seed at a uniform depth or cover seed adequately under less than ideal soil conditions. After starting the drill in the field, go back and examine the job it is doing.

   If possible, take a field trip to check a drill in operation.

   Form 8 CHECKING GRAIN DRILL PERFORMANCE IN THE FIELD

   The students can use Form 8 in checking the performance of a grain drill. Look for the following:

   a. Seeding depth and uniformity of placement in the row.

   b. Disk opener penetration. If press wheels are used they should be resting firmly on the ground.

   c. Closing and firming action of covering device.

      - Press wheels
      - Firming wheel
      - Drag chain
      - Other covering device

d. Straight seed tubes. Seed tubes that are sagging may check the free flow of seed from the metering device to the seed boot.

8. Speed of operation

The condition of the field will, to some extent, determine how fast a drill can operate efficiently and prevent unnecessary wear.

If a drill is operated too fast, it may bounce causing:

a. Springs being unable to maintain contact between the ground and openers, press wheels, and coulters.

b. Uneven seeding rates due to uneven operation of the drive wheels.

F. *Question:* **What safe operating procedures should _____ follow when working with his/her grain drill?**

Question: **What can result from unsafe work habits with and around the grain drill?**

- Personal injury or death
- Drill breakdown
- Property damage

Question: **When should safety precautions be taken?**

- Before operating
- During operation
- During maintenance
- When transporting

Class discussion about grain drill safety should bring out the students' knowledge of safety practices. Student answers would be recorded on the chalkboard.

1. Safety practices before operation

a. Do not work around or operate the grain drill without first reading the operator's manual. Most operator's manuals will have safety instructions marked with this symbol.

CAUTION:

b. Load the drill box with seed and fertilizer only when the drill is hitched to the tractor to prevent tipping. Never unhitch a loaded grain drill without blocking up front and rear of the drill.

c. When using a 3-point hitch, be sure the front of the tractor is weighted or heavy enough to handle the fully loaded drill.

d. Do not wear loose-fitting clothing which may catch in moving parts.

e. Put all safety shields in place.

2. Safety practices during operation

a. Have all safety shields in place.

b. Do not clean, adjust, or lubricate while the grain drill is in motion.

c. When working on the drill, lower the unit and stop the tractor engine.

d. Keep hands, feet, and clothing away from moving parts.

e. Have no riders on any part of the tractor, drawbar, or grain drill.

f. Have the area clear of all persons before moving the tractor and drill.

g. Drive carefully.

1) Adjust speed so that the drill functions properly under the field conditions.

2) Slow down for turns.

3) Do not drive near a ditch or bank. Remember, the drill is wider than the tractor.

4) Do not operate across slopes so steep that the tractor may tip over. Drive up and down steep slopes.

5) Shift tractor into lower gear on steep slopes. Do not let tractor get out of gear going down a steep slope.

6) Avoid sharp turns to keep drill from catching on the tractor tires.

7) Do not back or make sharp turns with the furrow openers in the ground. Backing will plug the openers and sharp turns will put too much strain on the openers.

h. Protect ears against loud noise by wearing hearing protection devices.

i. Keep away from furrow openers and marker disks when the drill is in motion.

j. Avoid use of alcohol, drugs, and smoking, as they may reduce driver reaction time and efficiency and make the operator more accident-prone.

3. Safety practices during maintenance

a. Always lower openers before working on the drill. If it is necessary to work on the openers in a raised position, be sure they are blocked up.

b. Block the wheels so the drill will not roll.

c. When cleaning with diesel fuel or other cleaning fluid, do not allow it to come in contact with the rubber seed tubes. Cleaning fluid will cause them to deteriorate.

d. When washing out the drill boxes, keep water out of the seed boot. Remove the seed tubes from the boot. Water will cause rusting of the metal and caking of the fertilizer.

e. Wear safety glasses when using compressed air to clean the drill.

f. Do not permit smoking, sparks, or open flames when combustible lubricants, fuels, or other liquids are being used. Use cleaning fluids only in a well-ventilated area.

g. Do not over-inflate tires. Over-inflation may cause them to fly apart with explosive force.

h. Before disconnecting hydraulic lines be sure to relieve pressure. Be sure all connections are tight before applying pressure to the system. The hydraulic fluid under pressure can penetrate the skin causing injury.

i. Do not use your hands when checking for hydraulic leaks. To avoid injury, use a piece of cardboard or wood.

j. Replace all guards and shields after performing maintenance on the grain drill.

4. Safety practices during transporting

a. Place the drill in the transport position, including folding drills and multiple hitches.

1) Raise and lock up furrow openers.
2) Raise and lock up markers.
3) Raise and lock up the jack stand.

4) Use safety chains.
5) Securely fasten hitch pin and stabilize drawbar.

b. Do not transport drill with seed or fertilizer in the drill box. The extra weight may damage the drill. Also the material may pack around the feed metering devices causing difficulty in turning when the drill is again used for seeding.

c. Remember that the drill is wider than the tractor.

d. Avoid low-hanging wires and branches that the markers may catch on.

e. Lock tractor brake pedals together.

f. Operate at safe speed — not more than 20 m.p.h.

1) Slow down on turns.
2) Gear down when going down steep slopes.
3) Slow down when traveling over rough ground or roads.
4) Stop slowly.

g. Use slow-moving vehicle (SMV) emblems and other warning devices as required by law.

VI PREPARING THE GRAIN DRILL FOR STORAGE

Question: **How should I prepare my grain drill for storage to be sure it will not deteriorate and will be ready to operate next season?**

Develop class discussion on the problem or situation. Use grain drill operator's manuals as a resource for supervised study. Draw from the student's own experiences and place the information on the chalkboard for transfer to the student's notebooks.

Caution: When using diesel fuel for cleaning, be careful it does not ignite. Use only in a well-ventilated place away from any sparks or flames.

Important! Do not allow diesel fuel or other cleaning fluid to get on the rubber feeding tubes as it will cause deterioration.

Possible class responses to the problem of storing the grain drill:

1. Clean the drill thoroughly. Use water under pressure, compressed air, vacuum, and cleaning solvent or diesel fuel.
2. Clean the seed boxes and seed metering devices. Old seed and trash left in the drill will collect and hold moisture, which will cause rusting.
3. Clean the fertilizer box and fertilizer metering devices. Fertilizer left in the fertilizer box and on drill parts will draw moisture, causing corrosion and "freezing" of moving parts. Coat all moving parts with oil.
4. Inspect all parts for breakage and wear. Order replacement parts as needed.
5. Paint over spots where paint is chipped.
6. Spray all moving parts with diesel fuel or lubricating oil.
7. Clean furrow openers and coat disks or shovels with oil or grease. Lower onto a board for storage. Relieve spring pressure or pressure rods.
8. Remove feeding tubes, wash, dry, and store in grain box. During the cleaning process never let oil or diesel fuel come in contact with the rubber tubes.

9. Remove chains, clean with diesel fuel, oil, and store in grain box.
10. Inspect hydraulic lines for leaks, cracks, and abrasions. Cover hose ends with dust covers.
11. Retract hydraulic arm for protection.
12. Lubricate the drill.
13. Inflate tires and block up drill to remove weight from them.

VII TROUBLE-SHOOTING

During the operation of the grain drill the operator may encounter mechanical problems which need correcting. Many of these problems in the field are caused by what the operator did incorrectly or failed to do. The students may be asked to react to the following question; place their responses on the chalkboard.

Question: **What might cause your grain drill operating problems in the field?**

Possible student responses:

1. Poor maintenance procedures which may cause part malfunction or breakage.
2. Improper adjustments so the drill cannot perform the functions for which it was designed.
3. Drill not being operated according to instructions (too fast, improper hitch, poor driving).

To avoid many operating problems, the operator should study the operator's manual and understand the functions of each part of the drill. The operator should observe the grain drill in use and observe the effect one adjustment may have on other parts of the drill and their adjustments.

After all the remedies to correct malfunctions have been applied, the operator may then decide that the machine was not properly designed to perform as he or she would like.

Trouble-shooting should be easier for the student who has completed the following forms during the study of the grain drill.

Form 1 PARTS OF THE GRAIN DRILL
Form 2 LUBRICATING THE GRAIN DRILL
Form 3 ADJUSTING THE GRAIN DRILL FOR RATE OF SEEDING
Form 7 ADJUSTING THE GRAIN DRILL FOR DEPTH OF SEEDING
Form 8 CHECKING THE GRAIN DRILL FOR PERFORMANCE IN THE FIELD

The operator's manual for the grain drill has a **trouble-shooting chart** that lists operating problems, their causes, and their remedies.

In part II the students were asked to respond to the question, "What problems have we encountered with our grain drills that would prevent us from doing a good job of seeding?" The responses were placed on the chalkboard and in the students' notebooks. This would be a good time to review the list and, in light of the study of the grain drill, to expand upon the list. This list should be similar to the operating problems found in the operator's manual trouble-shooting chart.

Since grain drills differ somewhat in their design (see Form I - Parts of the Grain Drill), trouble-shooting charts will not be the same for all situations. The proposed trouble-shooting chart is a composite of several trouble-shooting charts from drills with different designs. Some adjustments recommended for a particular grain drill design may not be on your grain drill. These adjustments would be taken care of in another way on your grain drill and would be in another part of the trouble-shooting chart. When applying the suggested remedies, you must refer to your operator's manual to determine correct procedures.

The grain drill operator must always be alert so that malfunctions can be identified as quickly as possible.

Form 9 TROUBLE-SHOOTING GRAIN DRILLS may be used as a guide in following a trouble-shooting procedure.

POTENTIAL YIELDS POSSIBLE WITH APPROVED PRODUCTION PRACTICES

	Potential Yields	
CROP	DARK SOIL	LIGHT SOIL
Corn	160 bu/A	130 bu/A
Soybeans	55	45
Wheat	75	50
Hay	7 tons	5 tons

PRACTICES REQUIRED TO OBTAIN POTENTIAL YIELDS

1. Use *accurate* and *adequate* applications of fertilizer, lime, and seed for high yields.
2. Plant high yielding varieties of crops —
   a. at the right time.
   b. at the right depth.
   c. at the right population and row widths.
   d. with seeds properly covered.
3. Use appropriate tillage and other management practices for erosion control.
4. Provide adequate drainage on land capable of supplying enough water to the crop.
5. Control weeds, insects, and plant diseases.

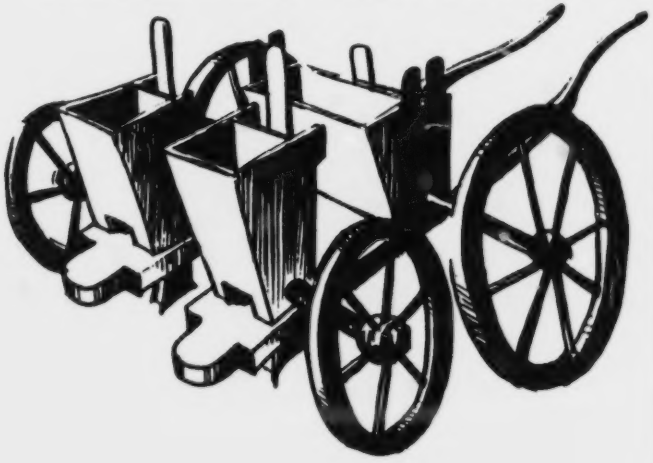
HISTORY OF GRAIN SEEDING

Hand Seeding

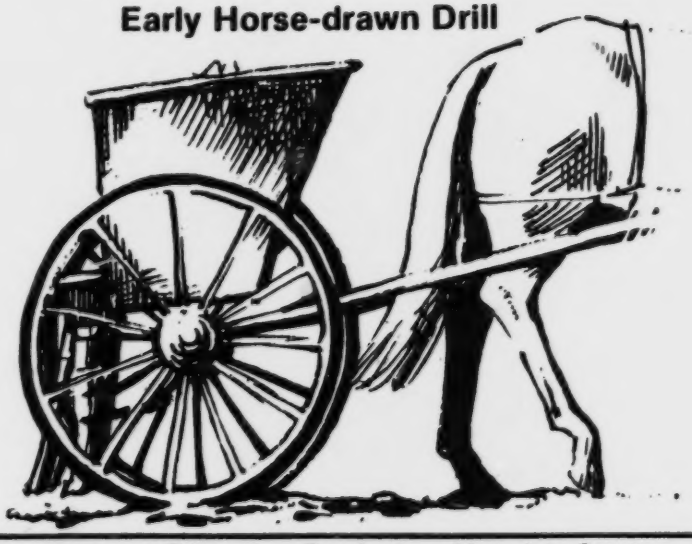
Grain Box on Hoe

Jethro Tull's Seed Drill

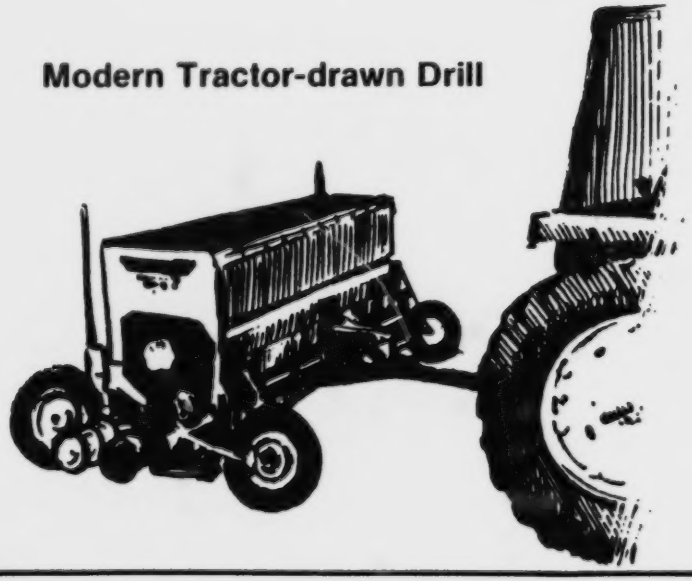
GRAIN BOX, SEED TUBES, AND HOES



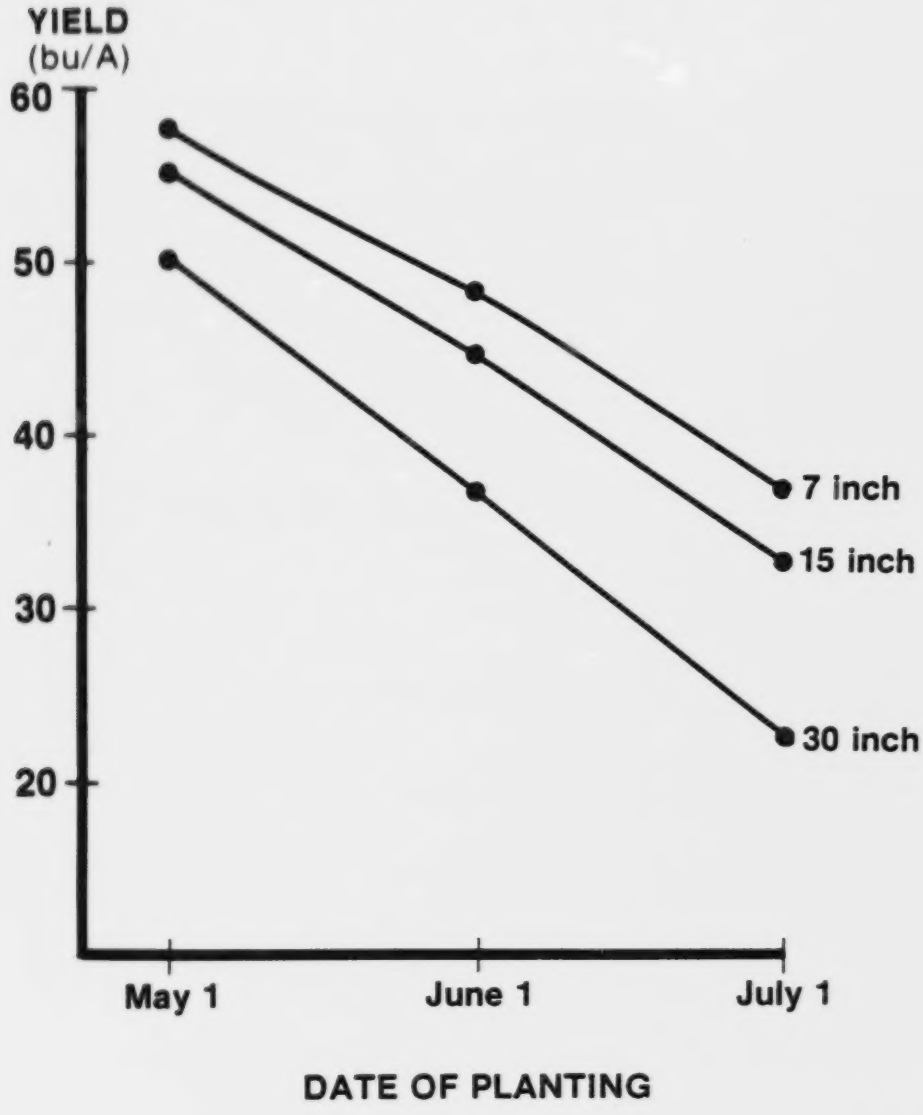
Early Horse-drawn Drill



Modern Tractor-drawn Drill



TM 2

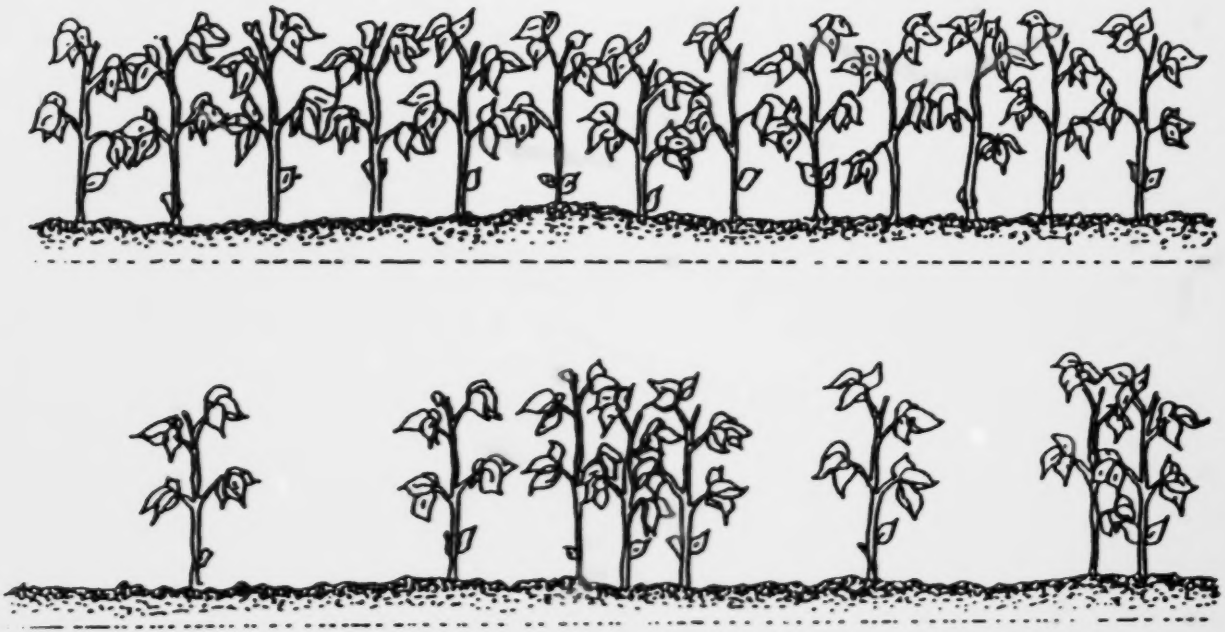


Effect of Planting Date on Soybean Yield

(Data from several studies, 1972-1981)

1983-84 Agronomy Guide, Cooperative Extension Service,
The Ohio State University

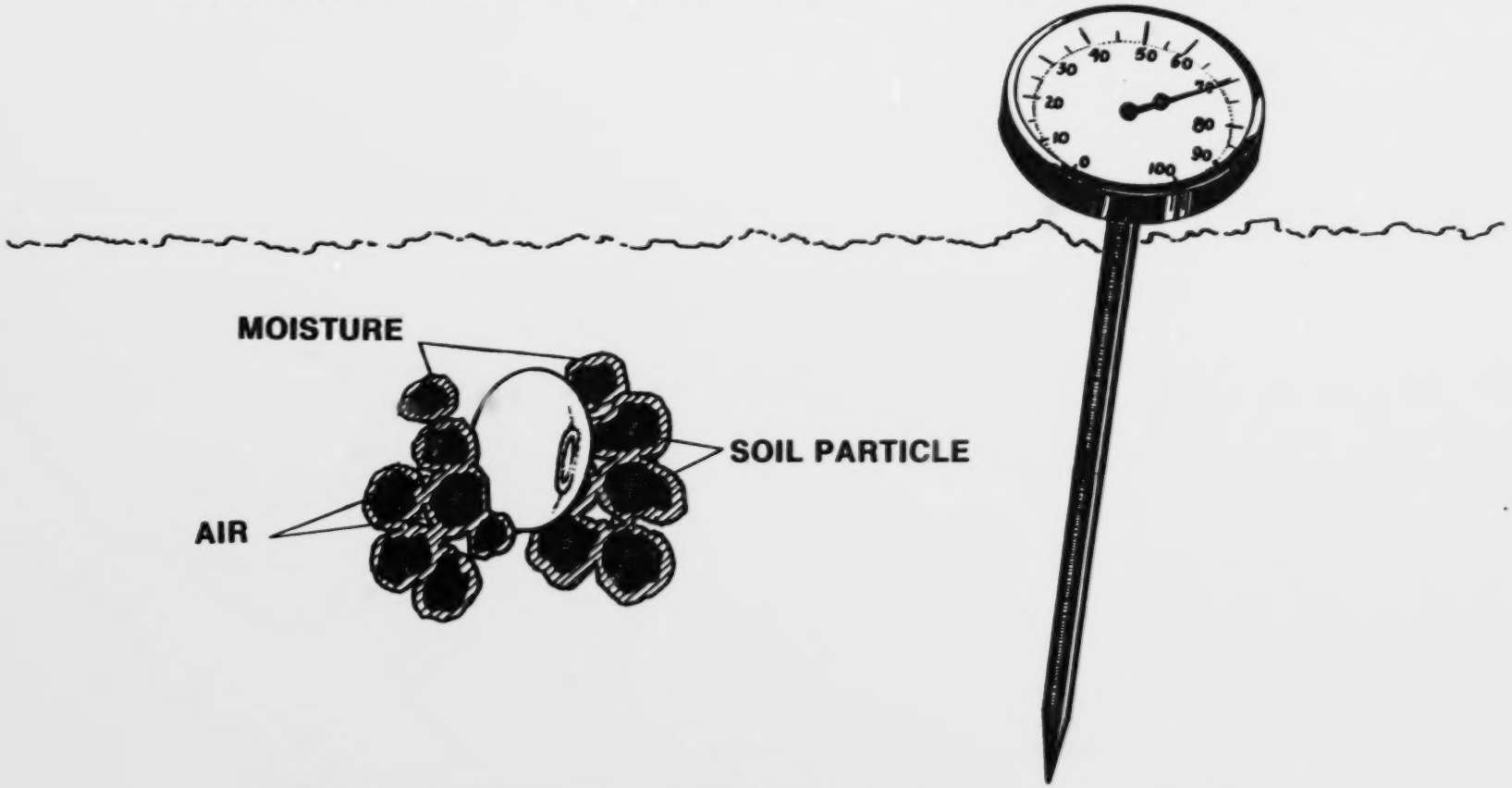
A GOOD STAND OF PLANTS IS REQUIRED FOR HIGH YIELDS



Poor distribution of plants in the row may result in a yield loss of up to 3 bu/A. *

* *1983-84 Agronomy Guide*, OSU Cooperative Extension Service, page 50

REQUIREMENTS FOR SEED GERMINATION

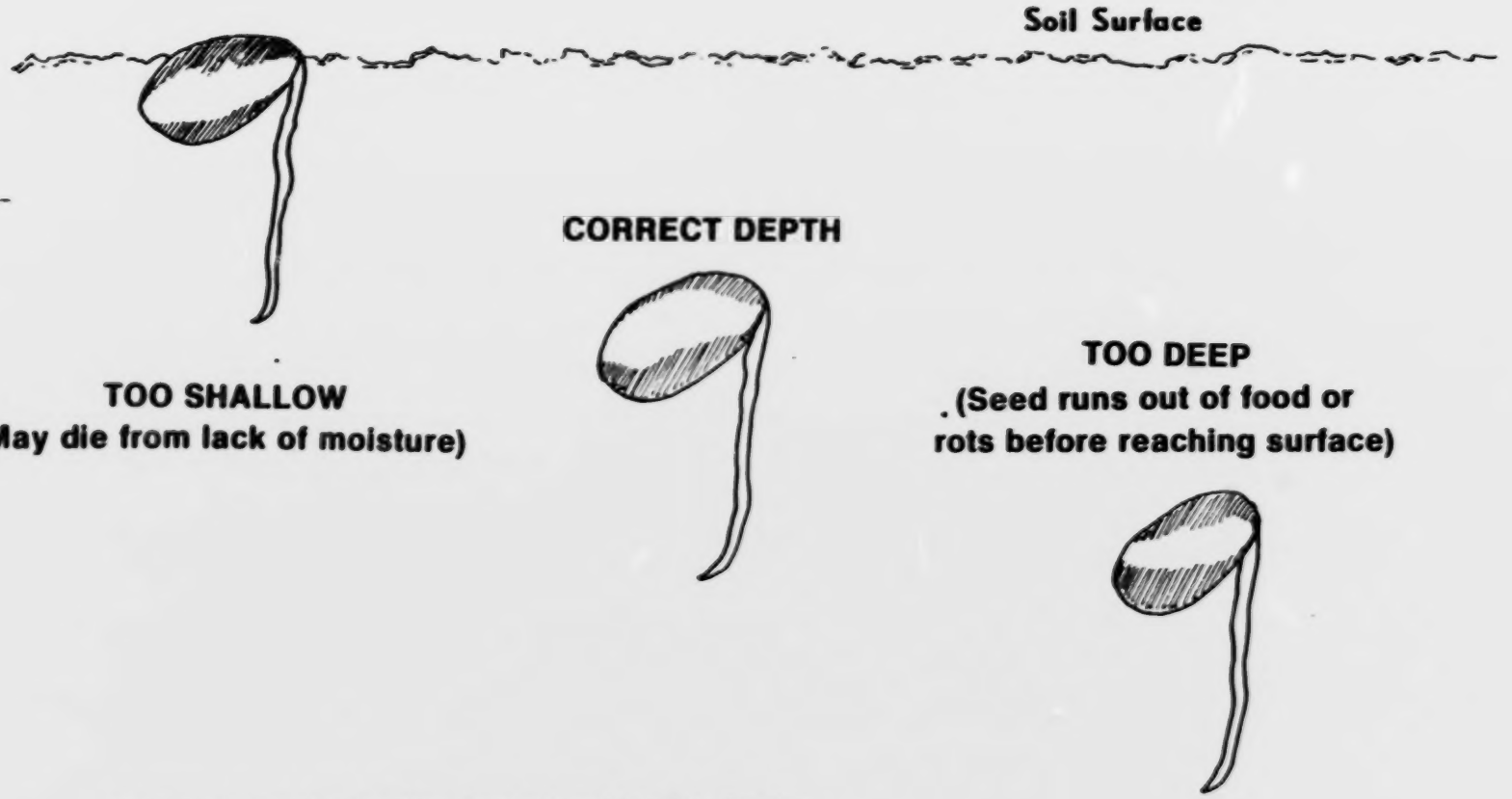


Moisture and air within a desirable temperature range are required for germination.

Well-prepared seed bed maintains temperature and provides seed with moisture and air.

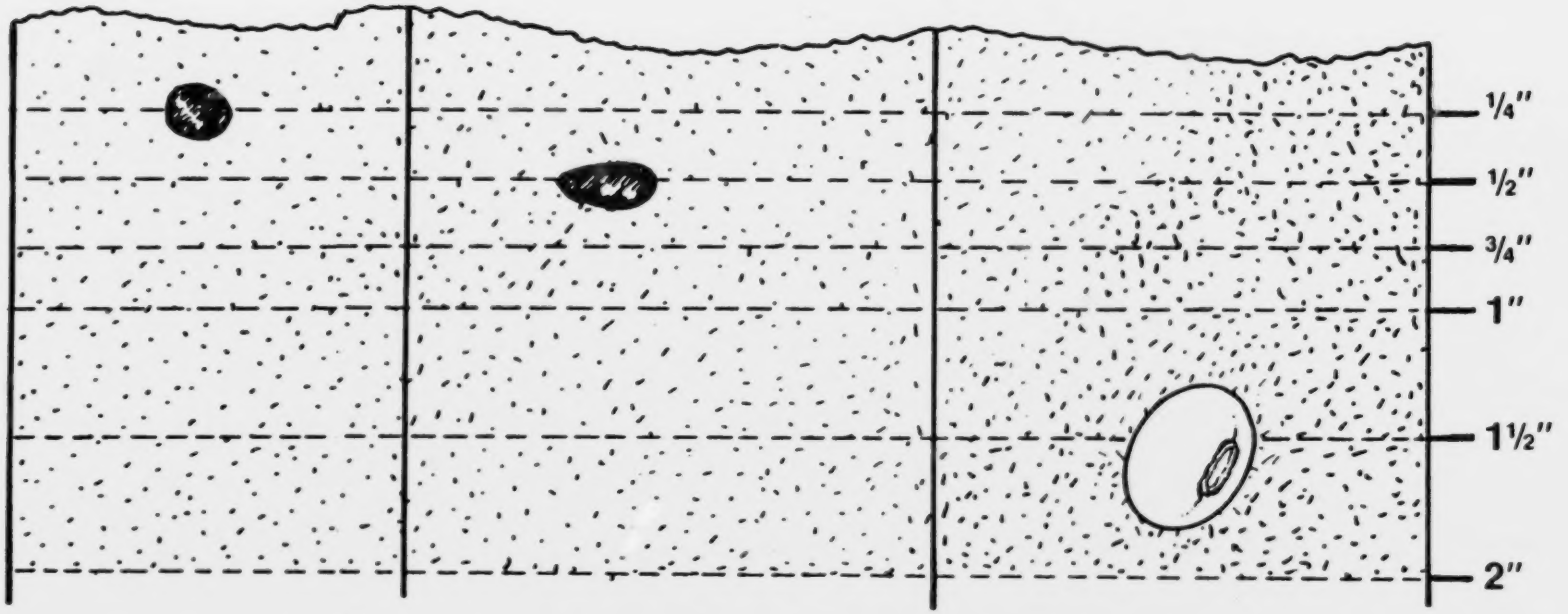
TM 5

PLANT SEEDS AT THE RIGHT DEPTH



TM 6

SEED SIZE SHOULD DETERMINE PLANTING DEPTH

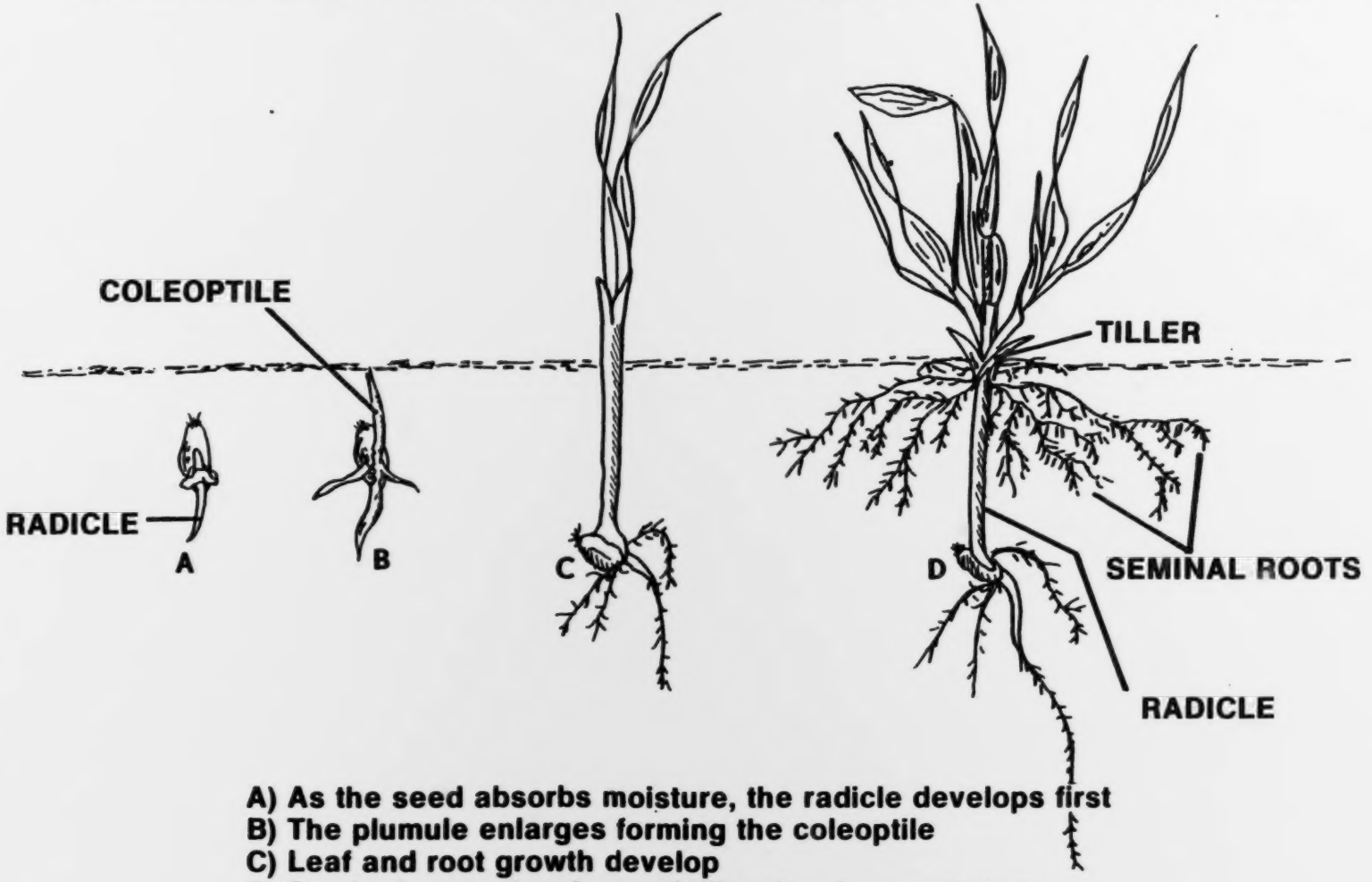


Small seeds — alfalfa, clovers, birdsfoot trefoil

Wheat and oats

Corn and soybeans

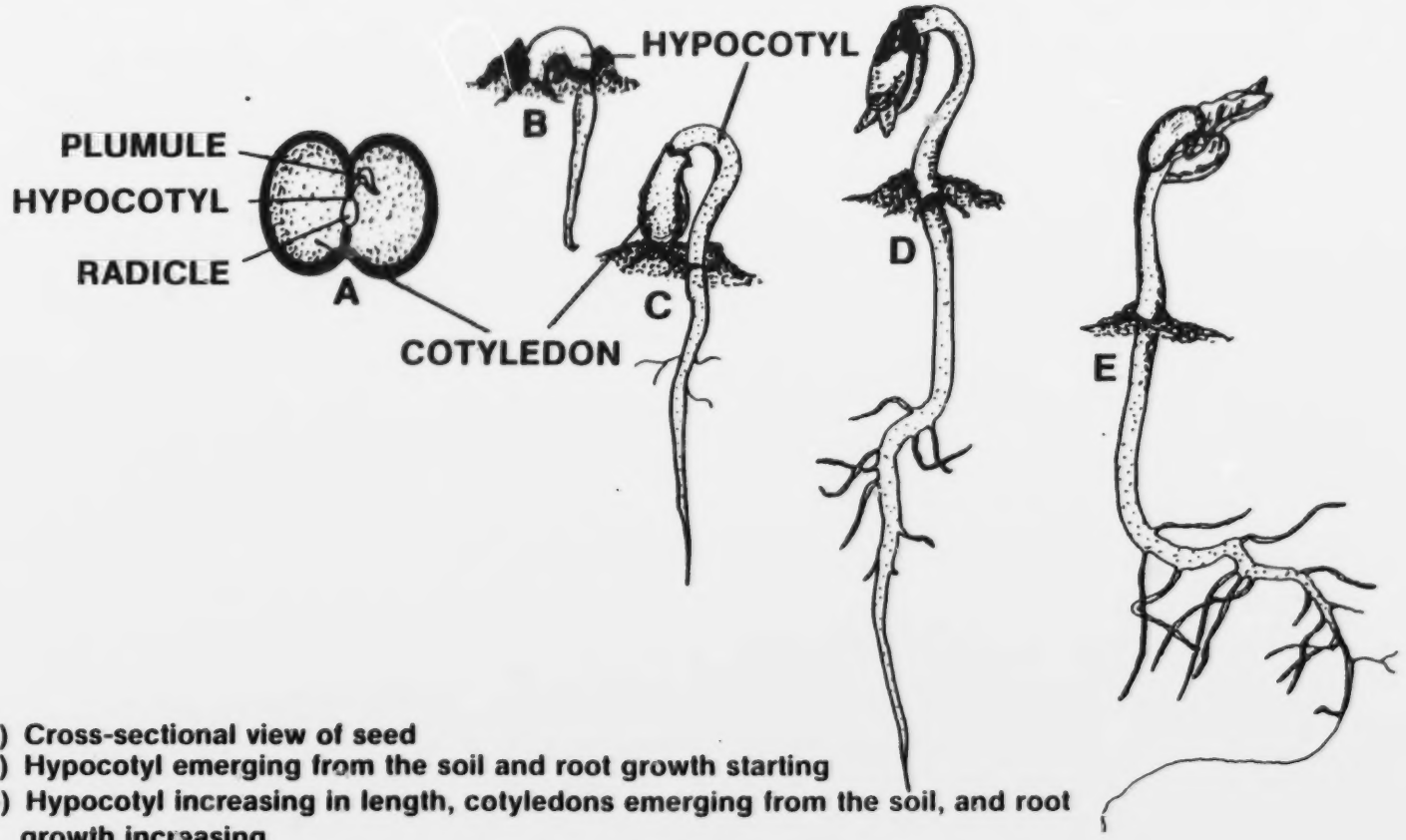
WHEAT GERMINATION AND SEEDLING GROWTH



A) As the seed absorbs moisture, the radicle develops first
B) The plumule enlarges forming the coleoptile
C) Leaf and root growth develop
D) Seminal roots develop and tiller development starts

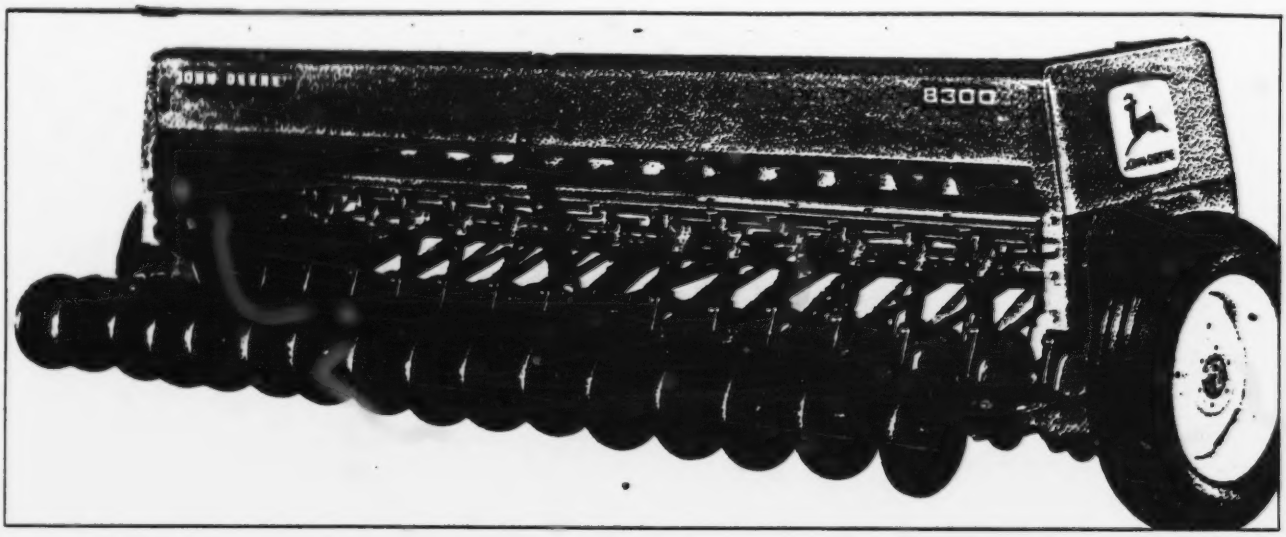
TM 8

SOYBEAN GERMINATION AND SEEDLING GROWTH

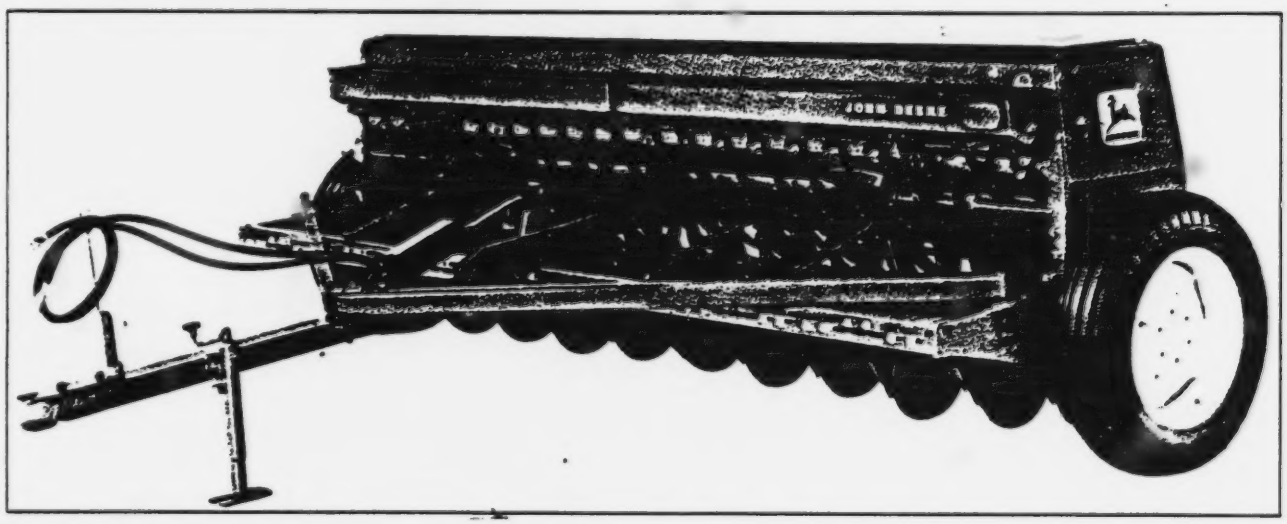


A) Cross-sectional view of seed
B) Hypocotyl emerging from the soil and root growth starting
C) Hypocotyl increasing in length, cotyledons emerging from the soil, and root growth increasing
D) Hypocotyl straightening and first leaf pair starting to emerge
E) Hypocotyl upright and first leaves increasing in growth. Until leaves become mature enough, the seedling obtains its food from the cotyledons.

END WHEEL DRIVE DRILL



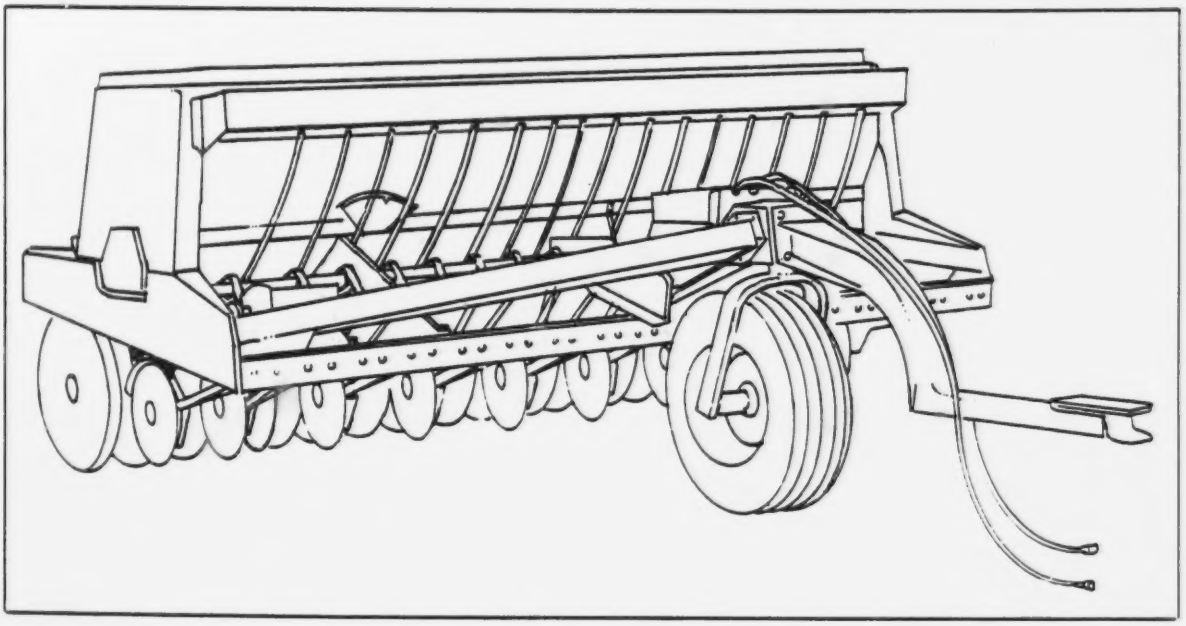
Grain and Fertilizer Drill with Press Wheels

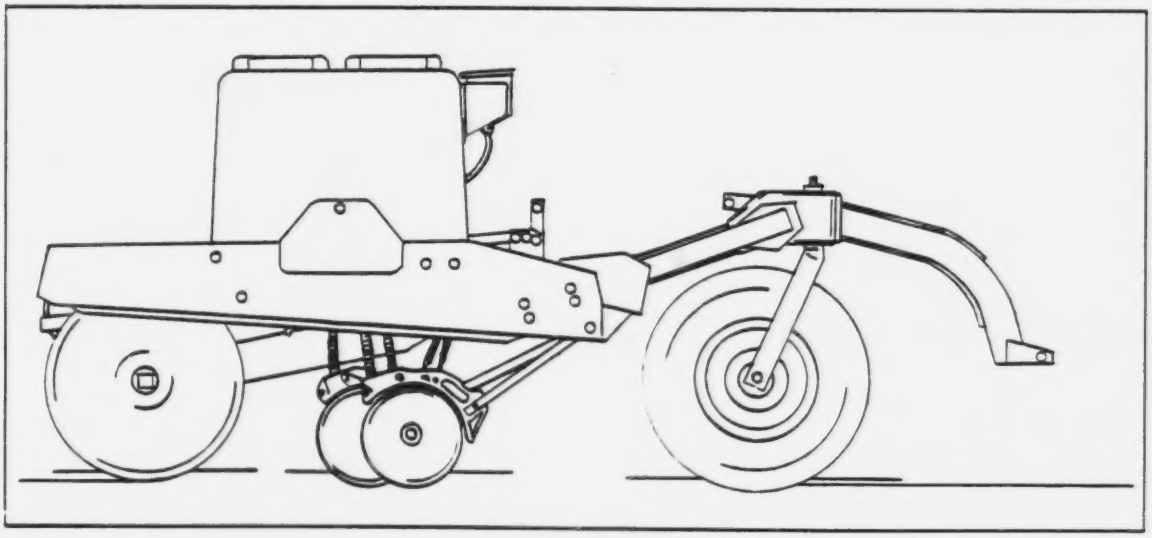


Grain Drill with Grass Seed Attachment

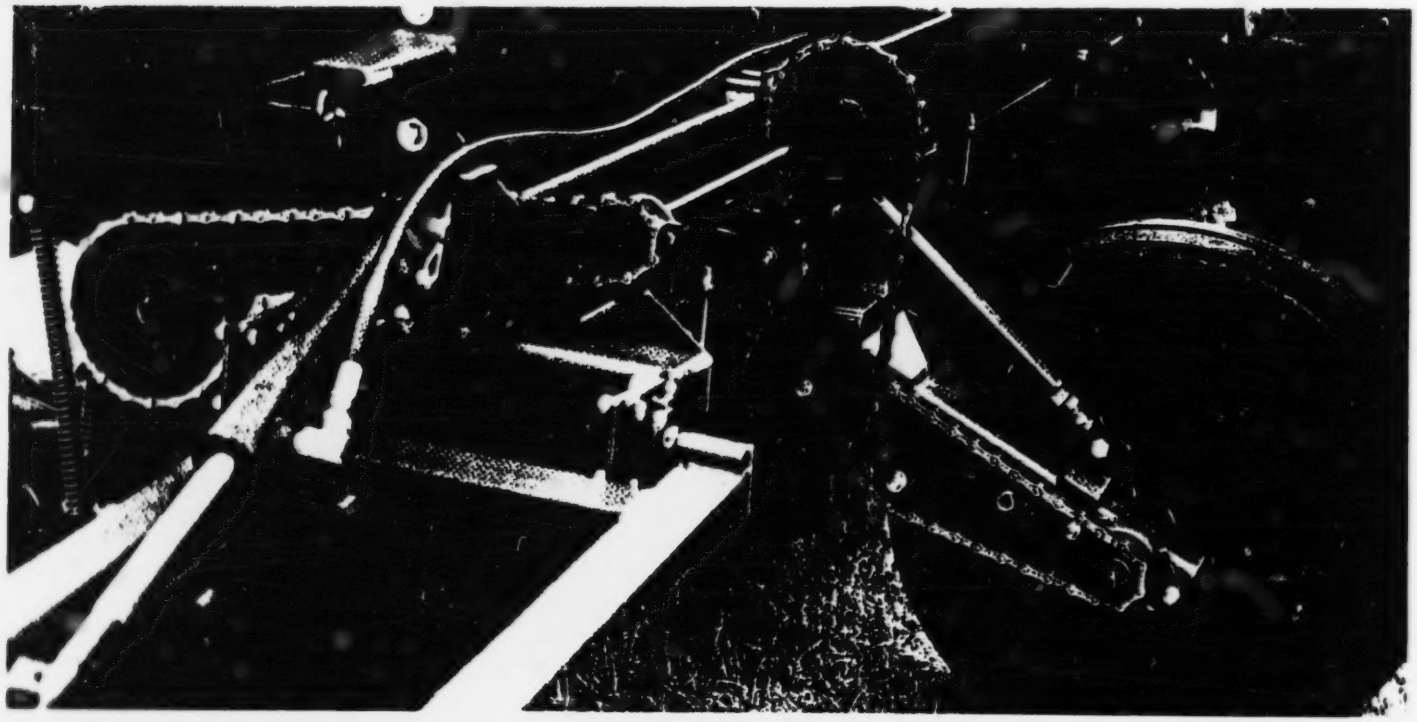
John Deere

PRESS WHEEL DRIVE DRILL

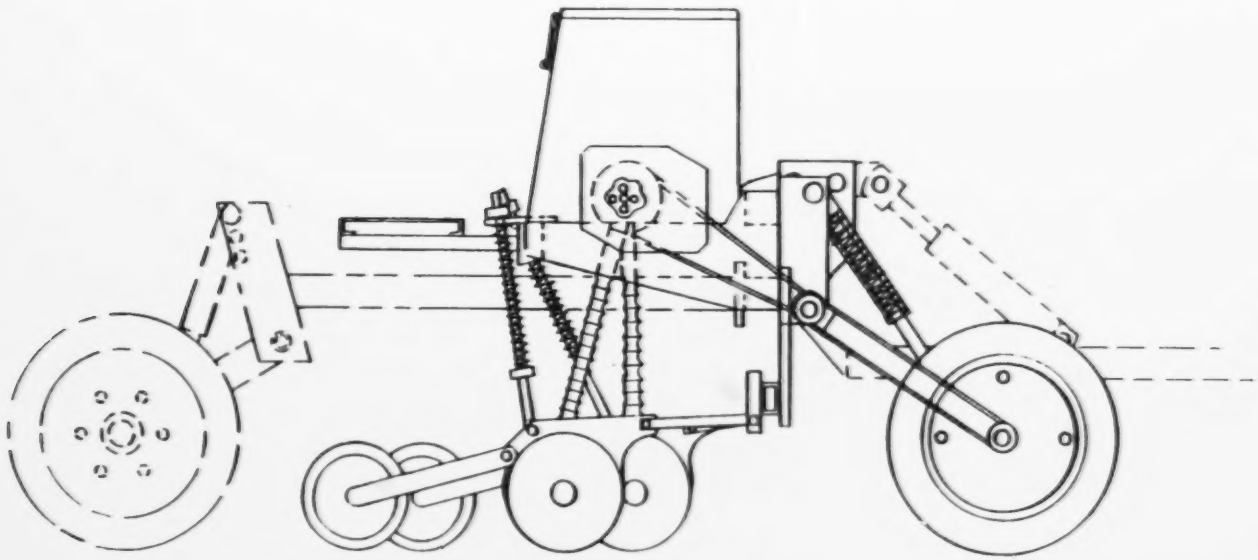




FRONT MOUNTED GAUGE WHEEL DRIVE DRILL



FRONT MOUNTED, SPRING LOADED WHEEL DRIVE DRILL

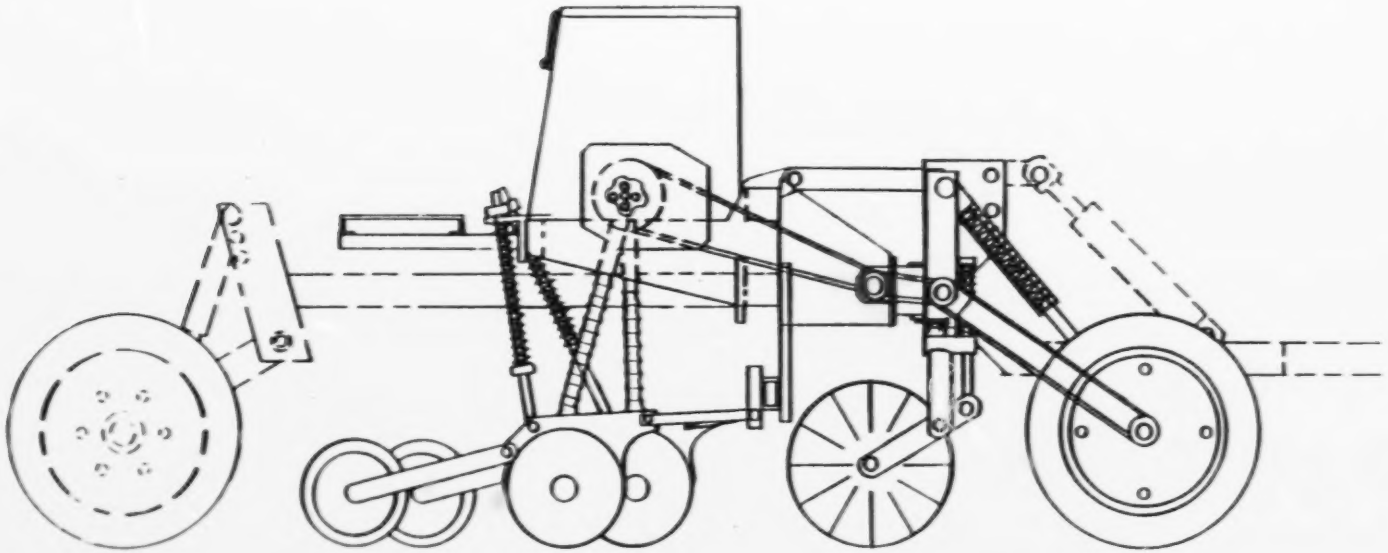


3-point hitch shown by solid lines

Pull-type hitch shown by solid and dashed lines

FRONT MOUNTED, SPRING LOADED WHEEL

DRIVE DRILL WITH NO - TILL ATTACHMENT



3-point hitch shown by solid lines

Pull-type hitch shown by solid and dashed lines

United Farm Tools

Ohio Agricultural Education Curriculum Materials Service

TM 14

NO-TILL COULTERS

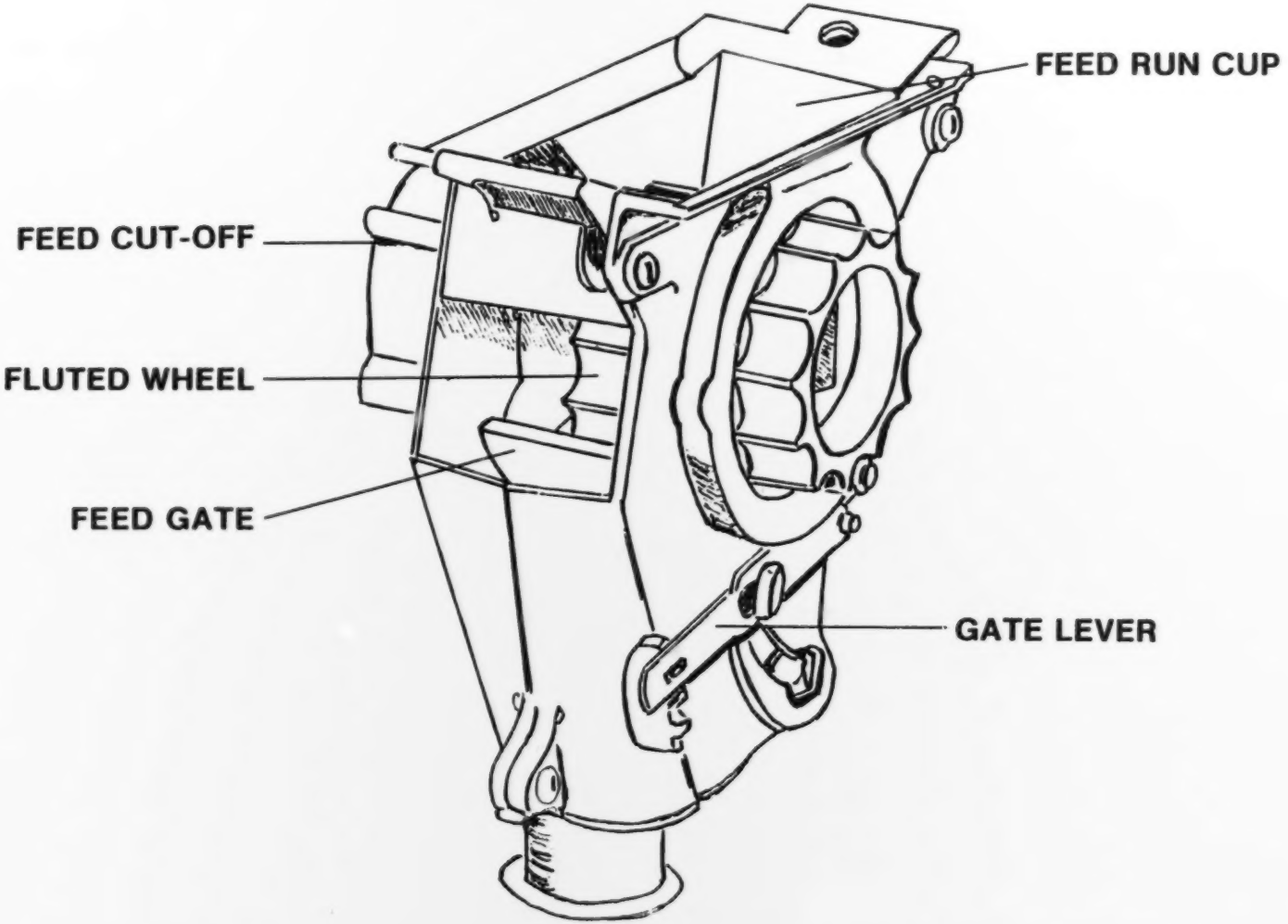
RIPPLE

- **Maximum penetration**
- **Opens narrow slot**
- **Minimum soil disturbance**

FLUTED

- **Maximum tillage action**
- **May throw soil**

FLUTED FEED UNIT



John Deere

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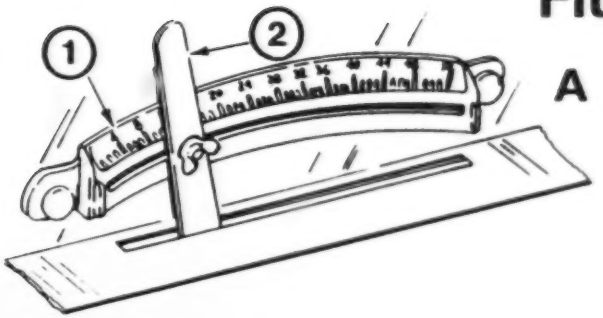
TM 16

CHANGING RATE OF SEEDING
Fluted Feed Drills

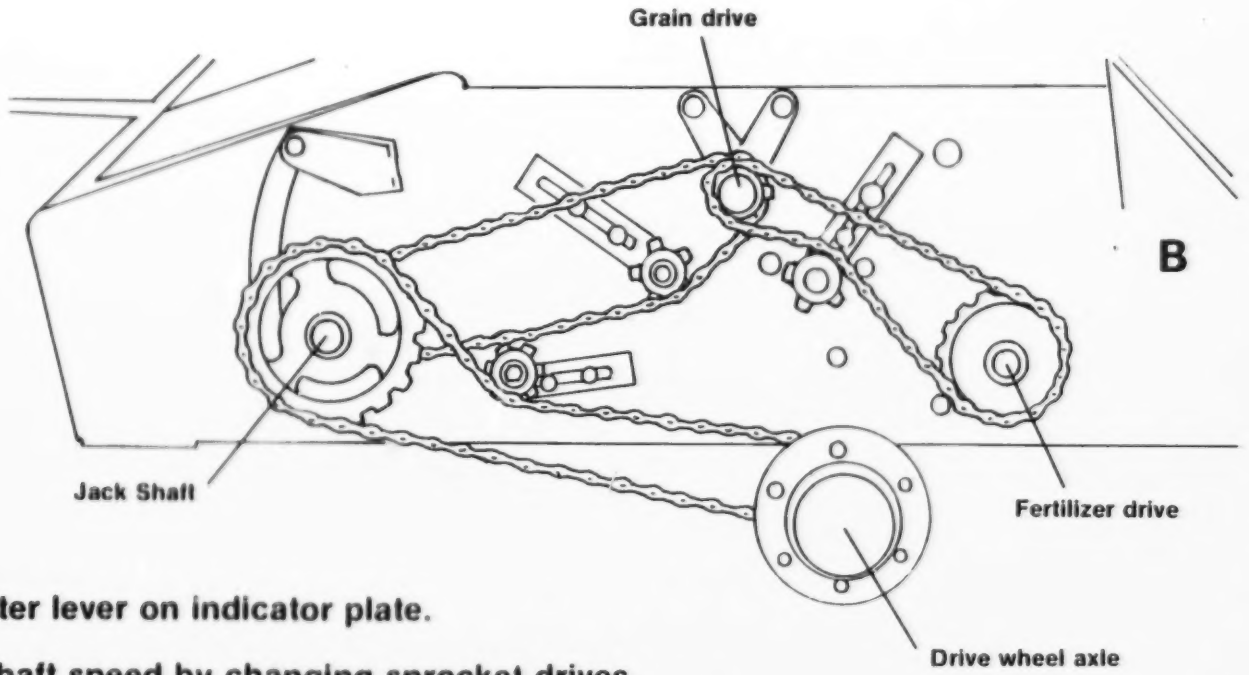


A

1) Indicator plate

2) Feed shifter lever

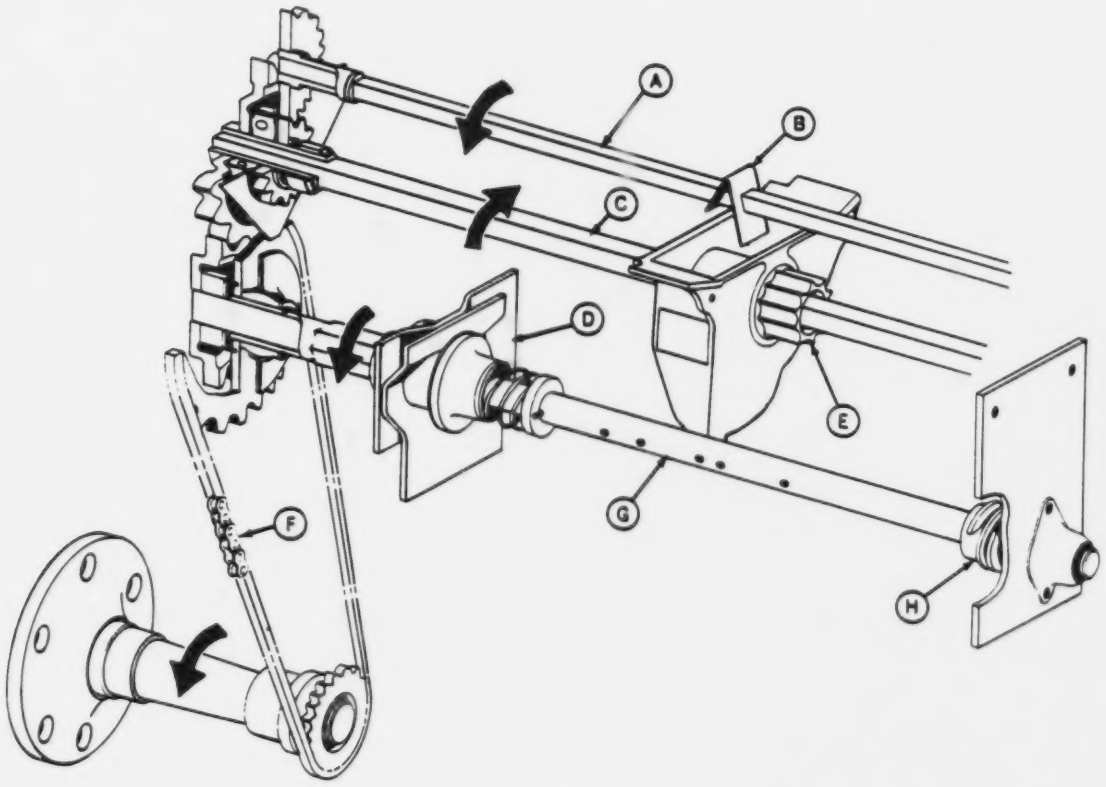
Transport wheel removed for better view



A) Moving feed shifter lever on indicator plate.

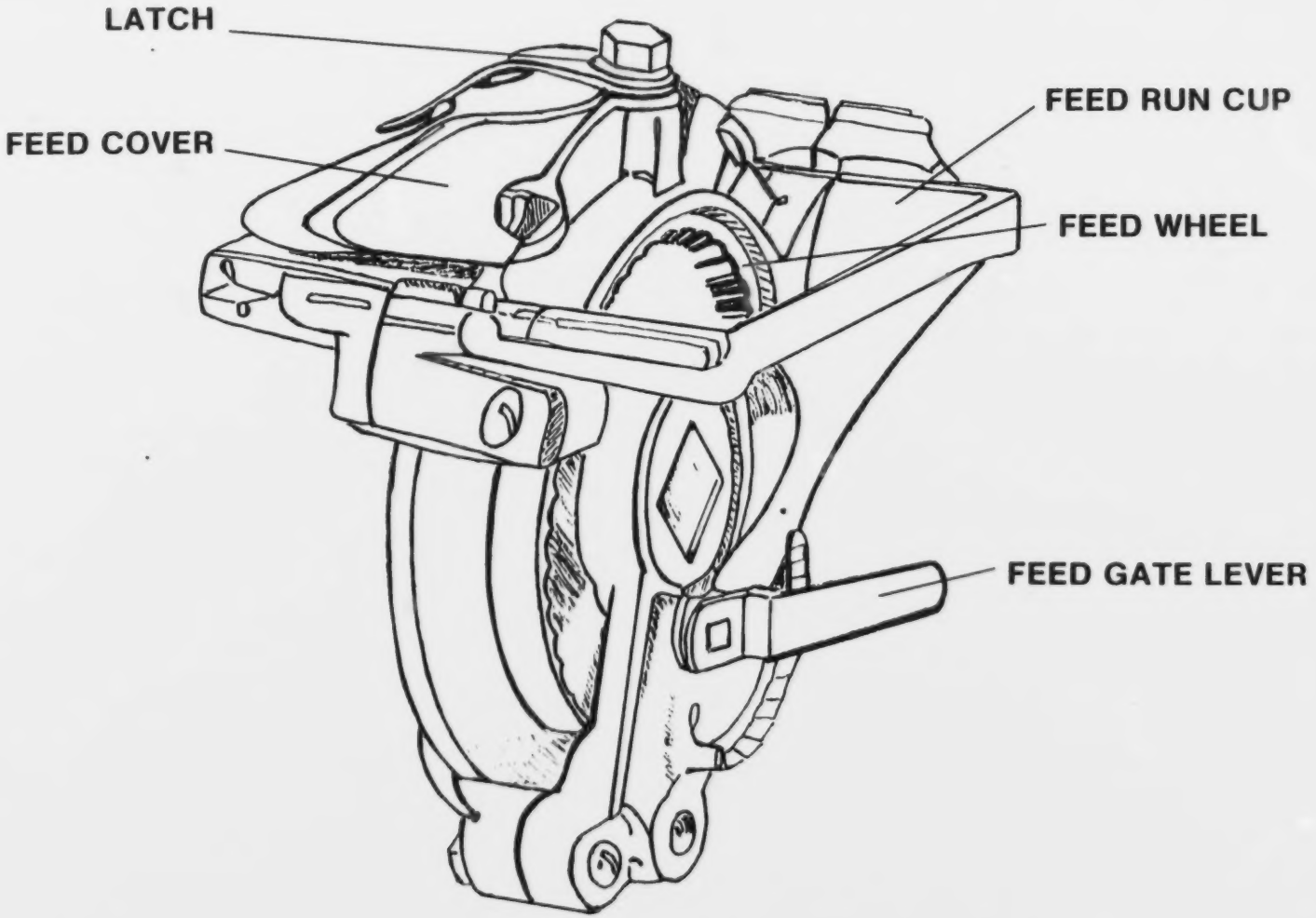
B) Changing feed shaft speed by changing sprocket drives.
(See operator's manual for both seeding and fertilizing rates.)

PLAIN GRAIN FLUTED-FEED DRIVE TRAIN



A) Agitator shaft
B) Agitator clip
C) Feed shaft
D) Clutch
E) Fluted-feed roll
F) Drive chain
G) Drive shaft
H) Acremeter screw

DOUBLE-RUN FEED UNIT



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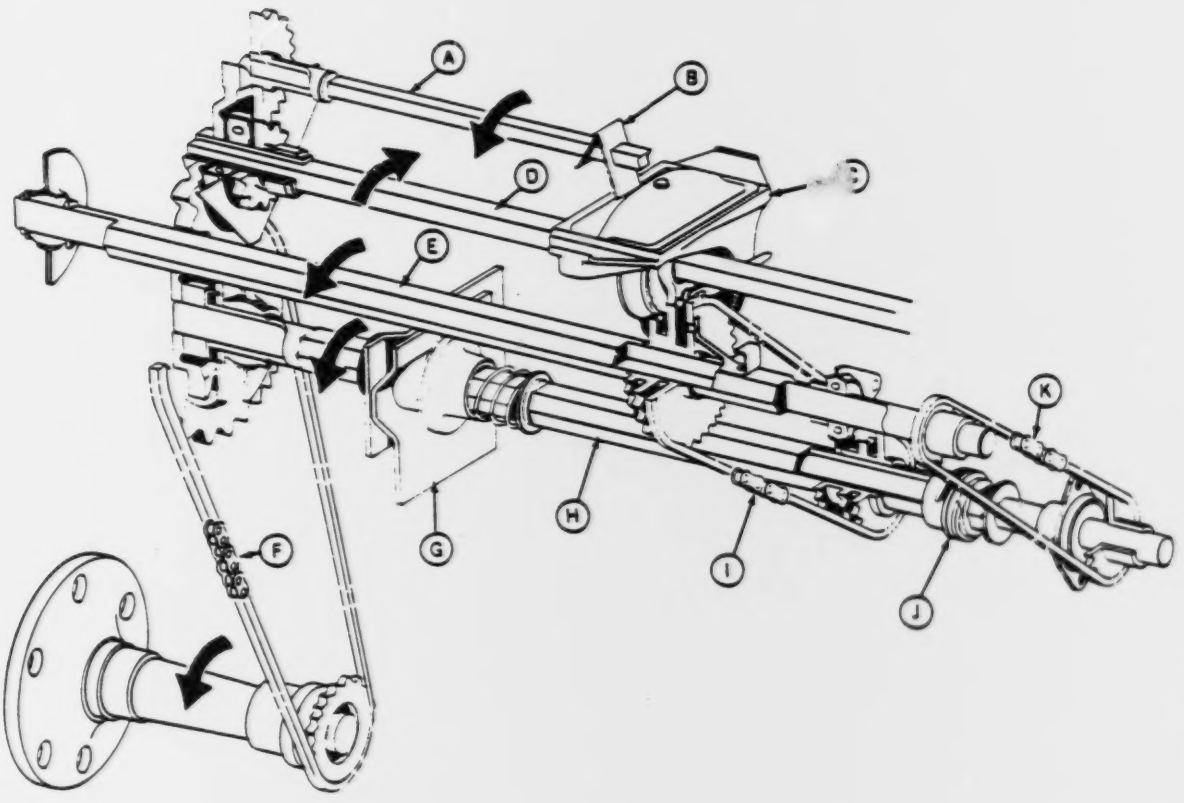
TM 19

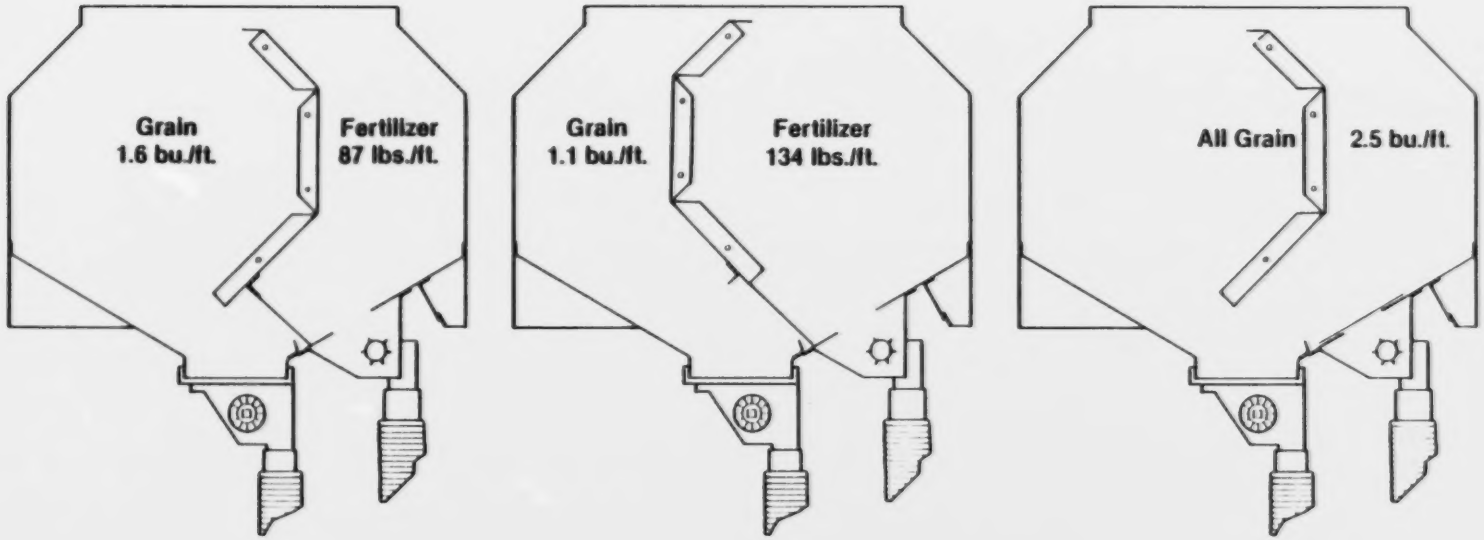
PLAIN GRAIN DOUBLE – RUN FEED DRIVE TRAIN



A) Agitator shaft
B) Agitator clip
C) Double-run feed cup
D) Feed shaft
E) Countershaft
F) Drive chain
G) Clutch
H) Drive shaft
I) Countershaft drive chain
J) Acremeter screw
K) Countershaft drive chain

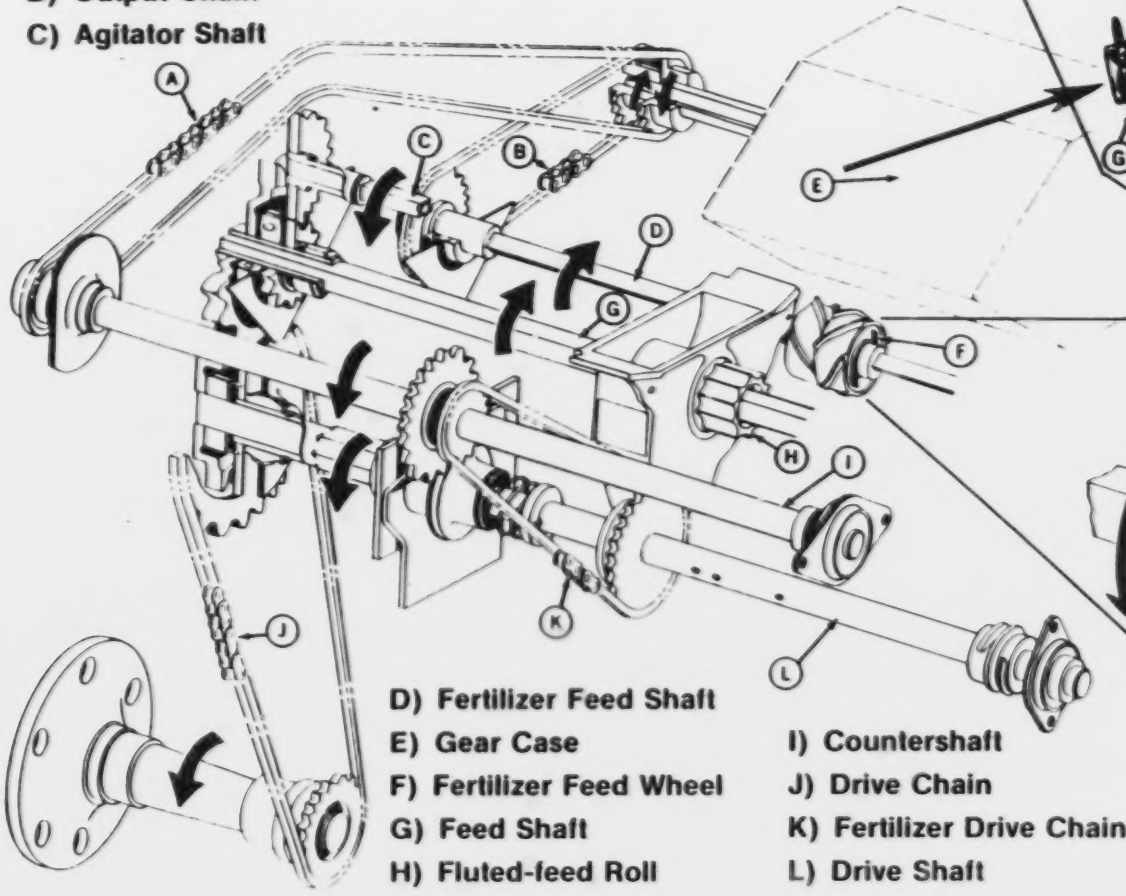
COMBINATION SEED AND FERTILIZER BOX

Some drills with fertilizer attachments have separate grain and fertilizer boxes.



GRAIN AND FERTILIZER FLUTED FEED DRIVE

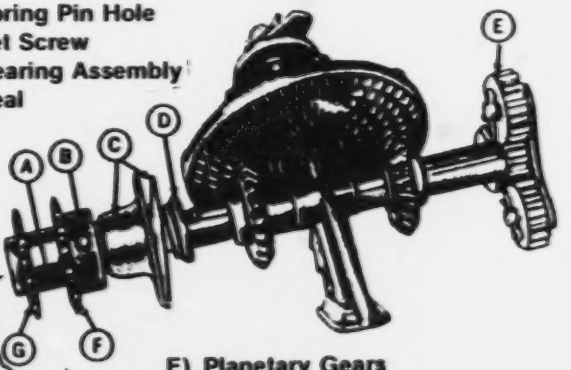
A) Input Chain
B) Output Chain
C) Agitator Shaft



D) Fertilizer Feed Shaft
E) Gear Case
F) Fertilizer Feed Wheel
G) Feed Shaft
H) Fluted-feed Roll
I) Countershaft
J) Drive Chain
K) Fertilizer Drive Chain
L) Drive Shaft

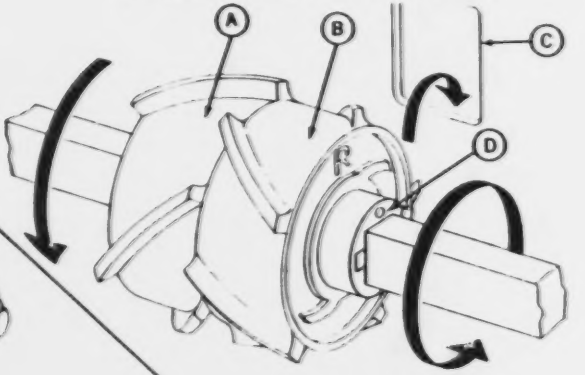
GEAR CASE — GEARS EXPOSED

A) Spring Pin Hole
B) Set Screw
C) Bearing Assembly
D) Seal



E) Planetary Gears
F) Input Sprocket
G) Output Sprocket

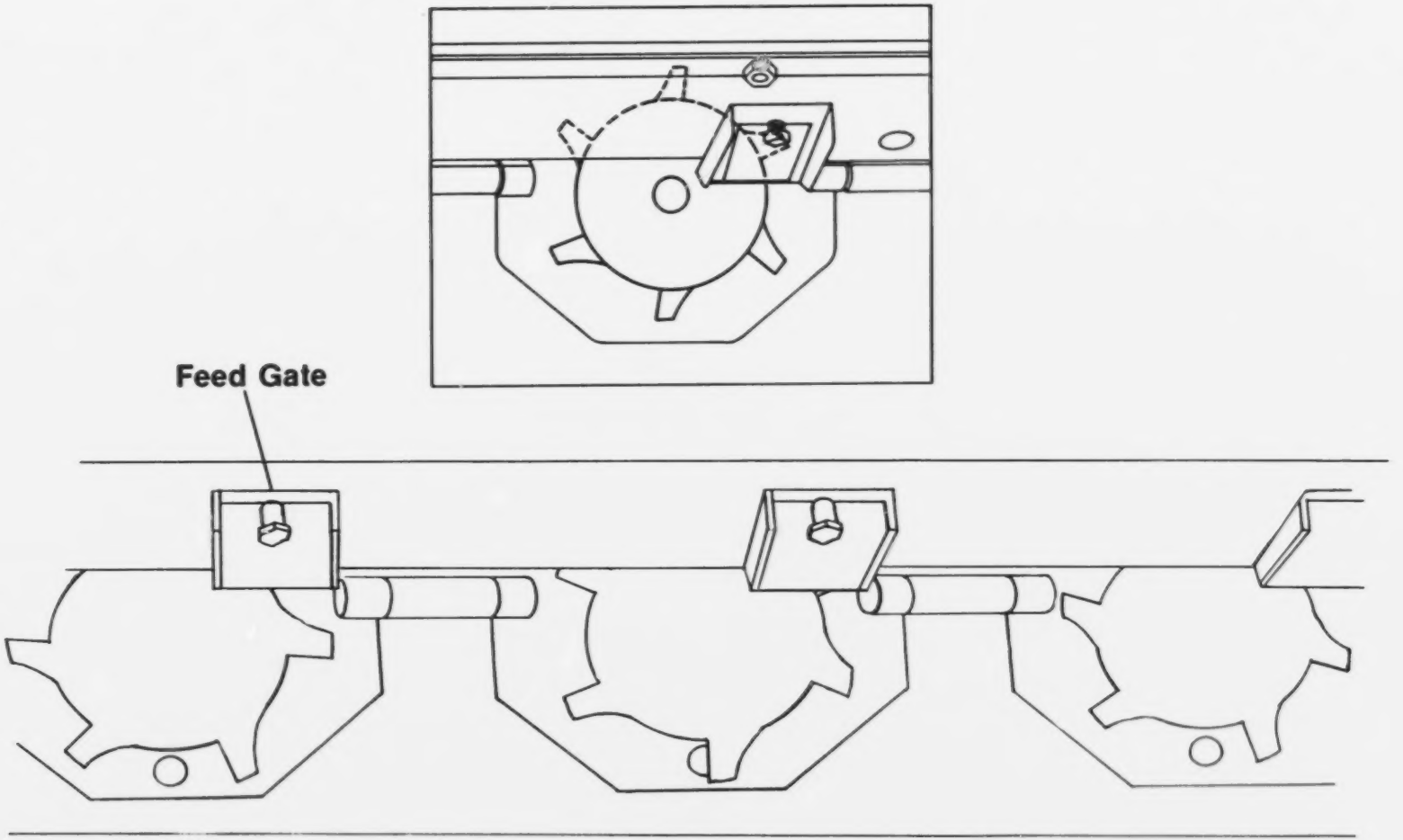
FERTILIZER FEED WHEEL



A) Left-hand Half
B) Right-hand Half
C) Discharge Hole
D) Dots

TM 22

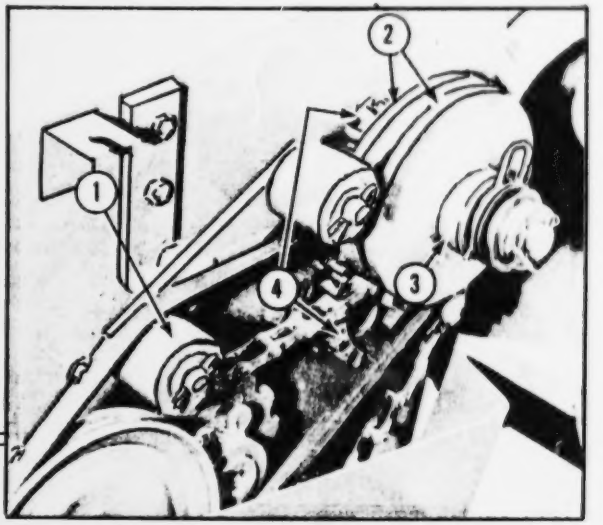
STAR WHEEL FERTILIZER METERING SYSTEM

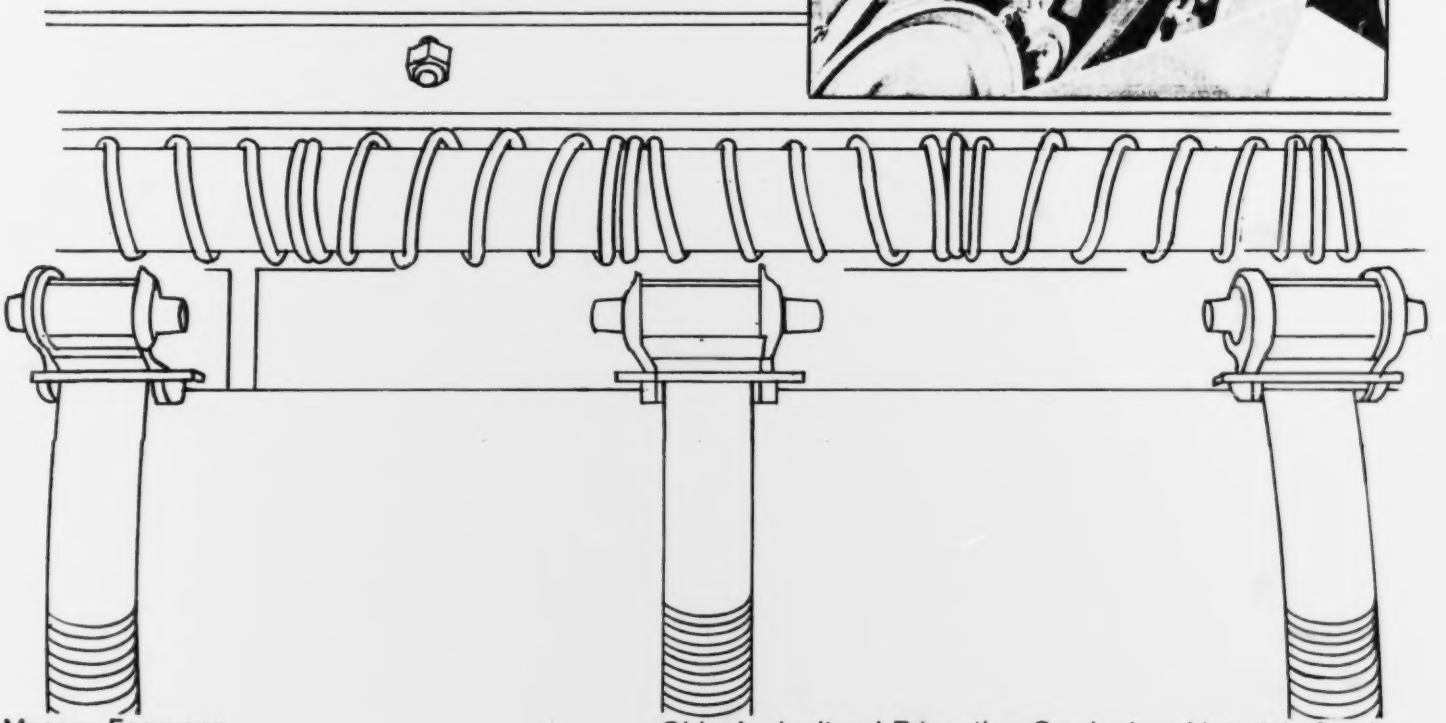


WIRE WORM FERTILIZER METERING SYSTEM

VARIABLE SPEED DRIVE PULLEY
(Combination Drill)

1) Belt Tightener
2) Pulley Halves
3) Washers
4) Drive Gears





Massey Ferguson

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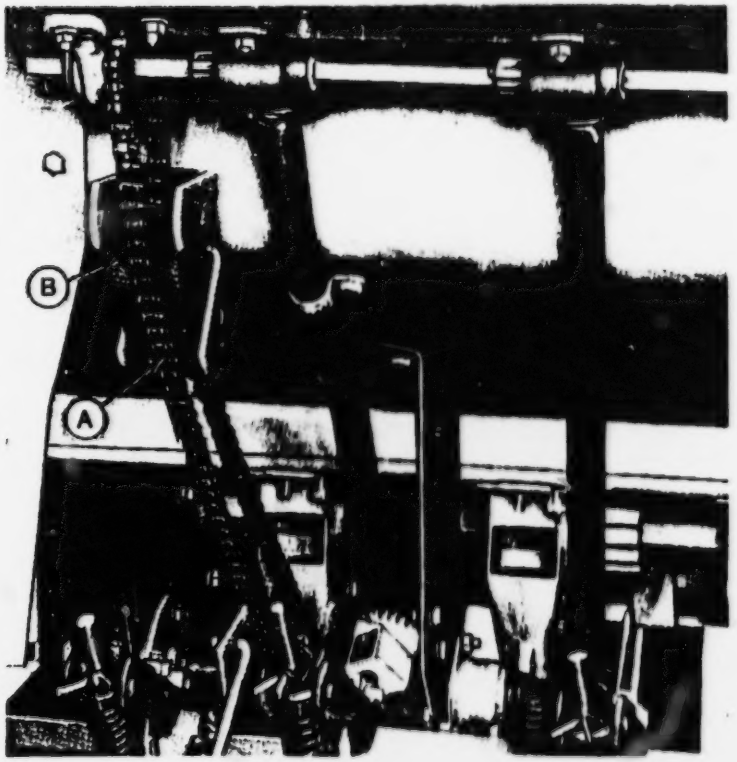
GRASS SEED ATTACHMENT

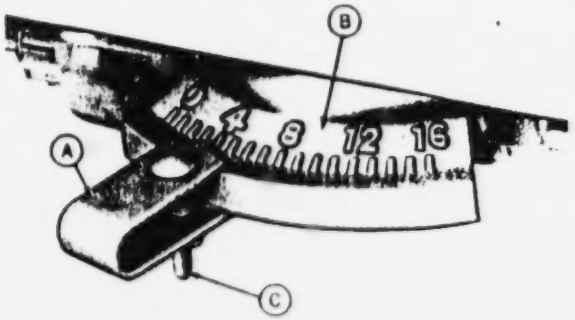
DRIVE SHAFT AND FLUTED FEEDS

GRASS SEED BOX



A) Drive Chain
B) Drive Chain Guide

GRASS SEED FEED SHIFTER



A) Shifter
B) Index
C) Wing Nut

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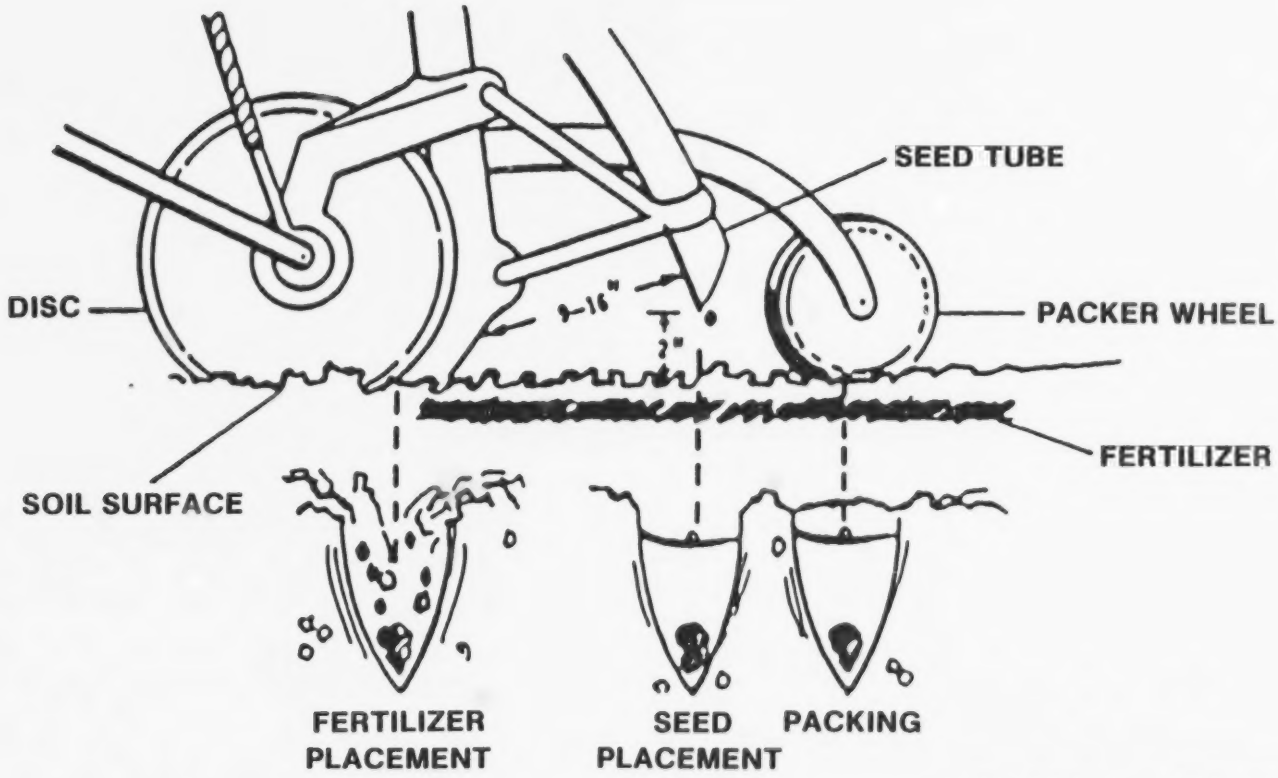
TM 25

BAND SEEDING ATTACHMENT

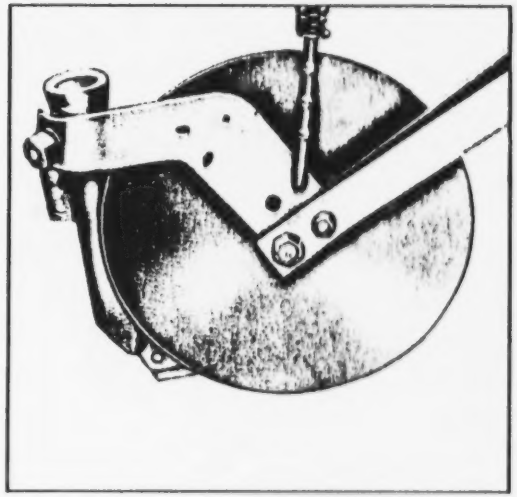


Agronomy Guide, Department of Agronomy, The Ohio State University

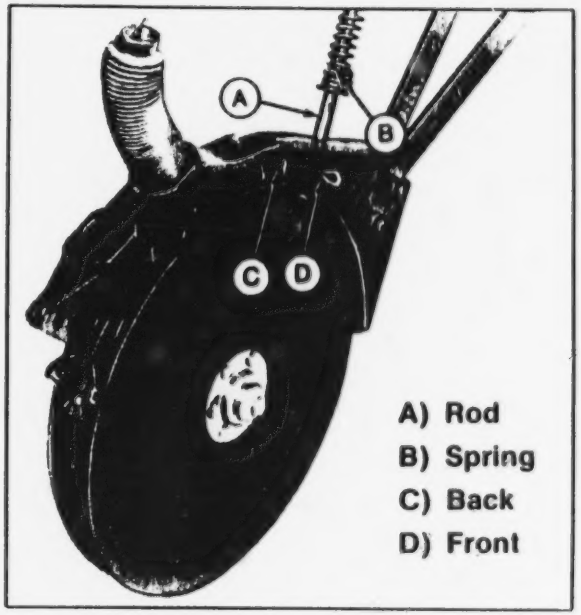
Ohio Agricultural Education Curriculum Materials Service

TM 26

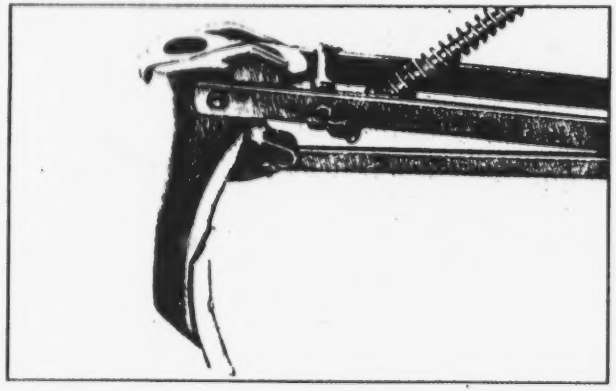
FURROW OPENERS



Single Disk

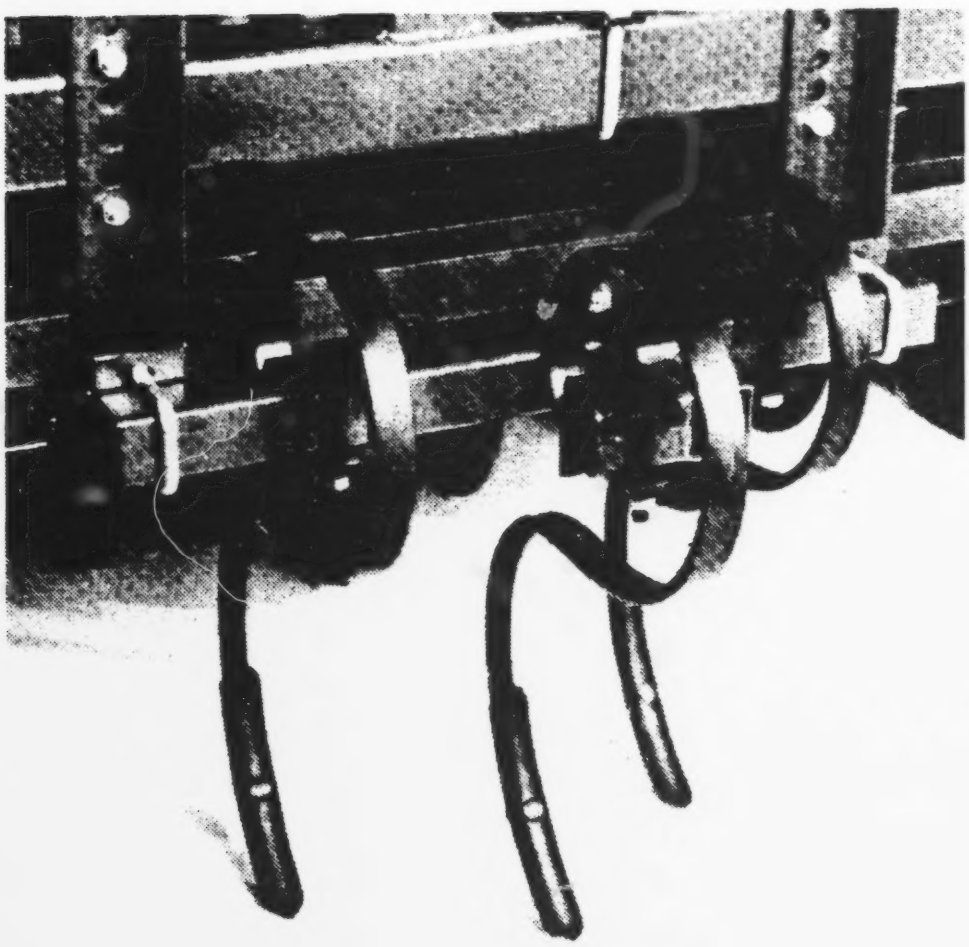


Double Disk

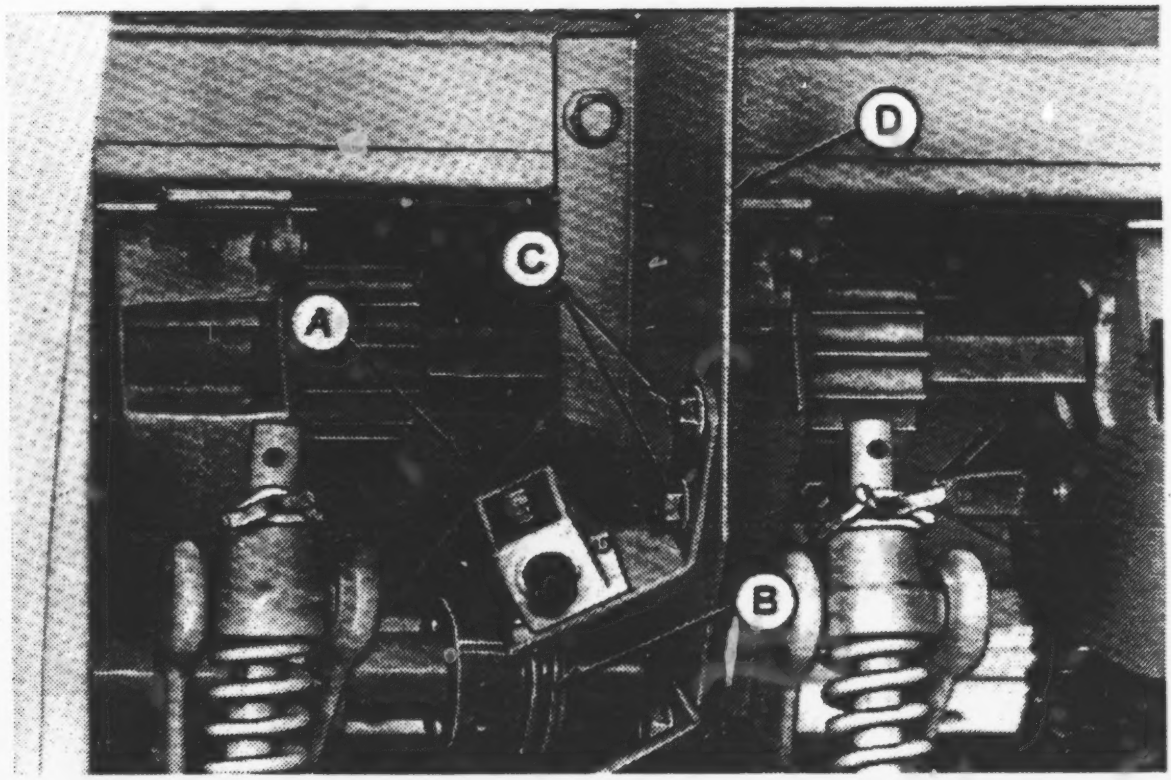


Shovel or Hoe

TRACTOR TIRE TRACK REMOVER

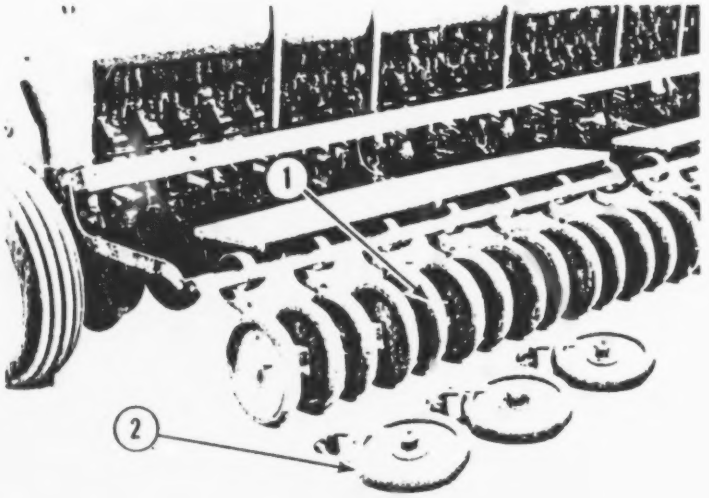


ACREAGE COUNTER



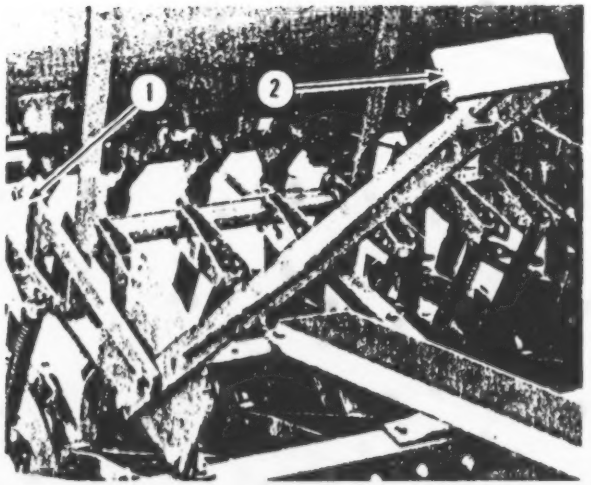
A - Drive Gear
B - Worm Gear
C - Attaching Bolts
D - Support Bracket

SEED COVERING AND FIRMING DEVICES



1) Double-mounted Press Wheels
2) Single-mounted Press Wheels

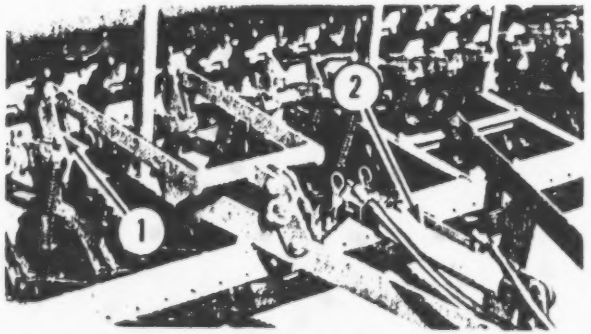
LIFTING MECHANISMS



HAND LEVER LIFT

1) Pressure Shaft Bracket

2) Handle

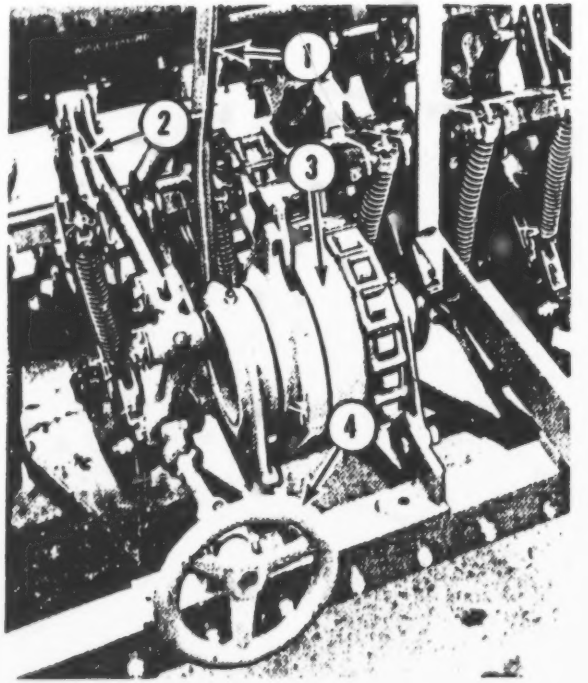


HYDRAULIC POWER LIFT

1) Pressure Shaft Bracket and Lift Arm

2) Hydraulic Cylinder

Massey Ferguson



MECHANICAL POWER LIFT

1) Trip Lever

2) Pressure Shaft Bracket

3) Clutch Assembly

4) Depth Adjustment Hand Wheel

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TM 31

ROTATING DRIVE SHAFTS

Grain, Fertilizer, and Grass Feed Drive Shafts

ROTATING GRAIN FEED DRIVE SHAFT

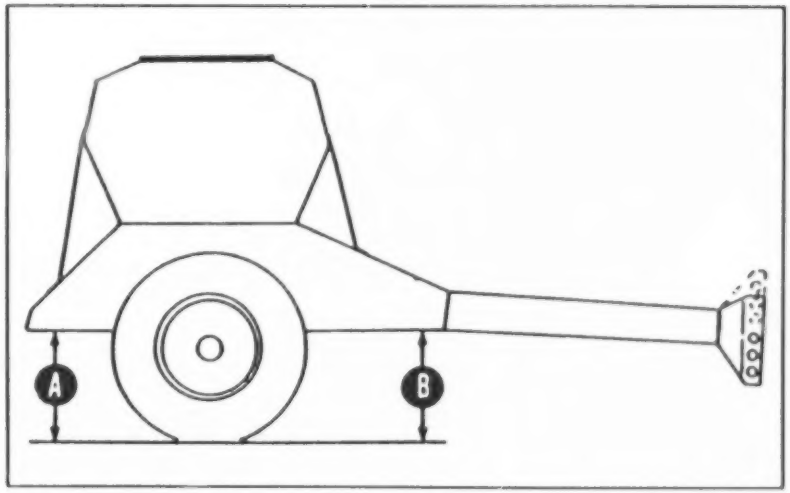
Rotate all drive shafts to assure free rotation at—

- **start of drilling season**
- **start of each day**
- **fertilizer shaft after transporting drill with fertilizer in hopper**
- **grain shaft when using treated seed if standing one hour or more**

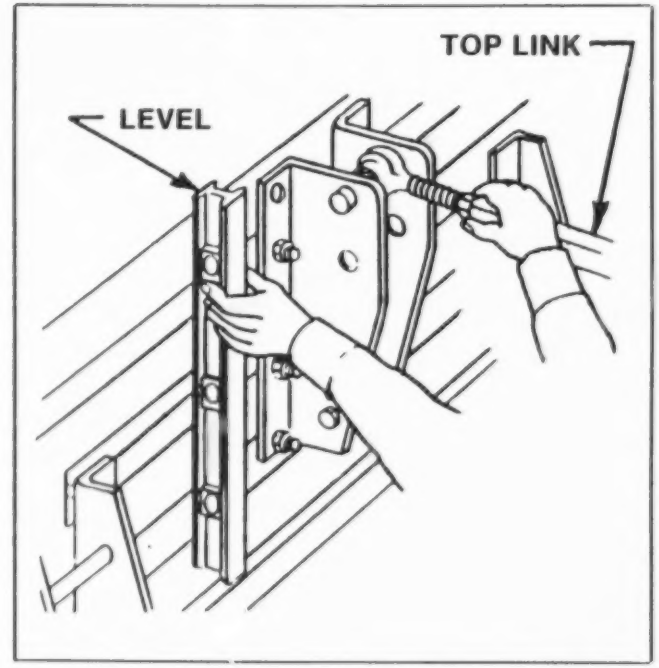
Massey Ferguson

Ohio Agricultural Education
Curriculum Materials Service

HITCHING DRILL IN LEVEL POSITION



International Harvester



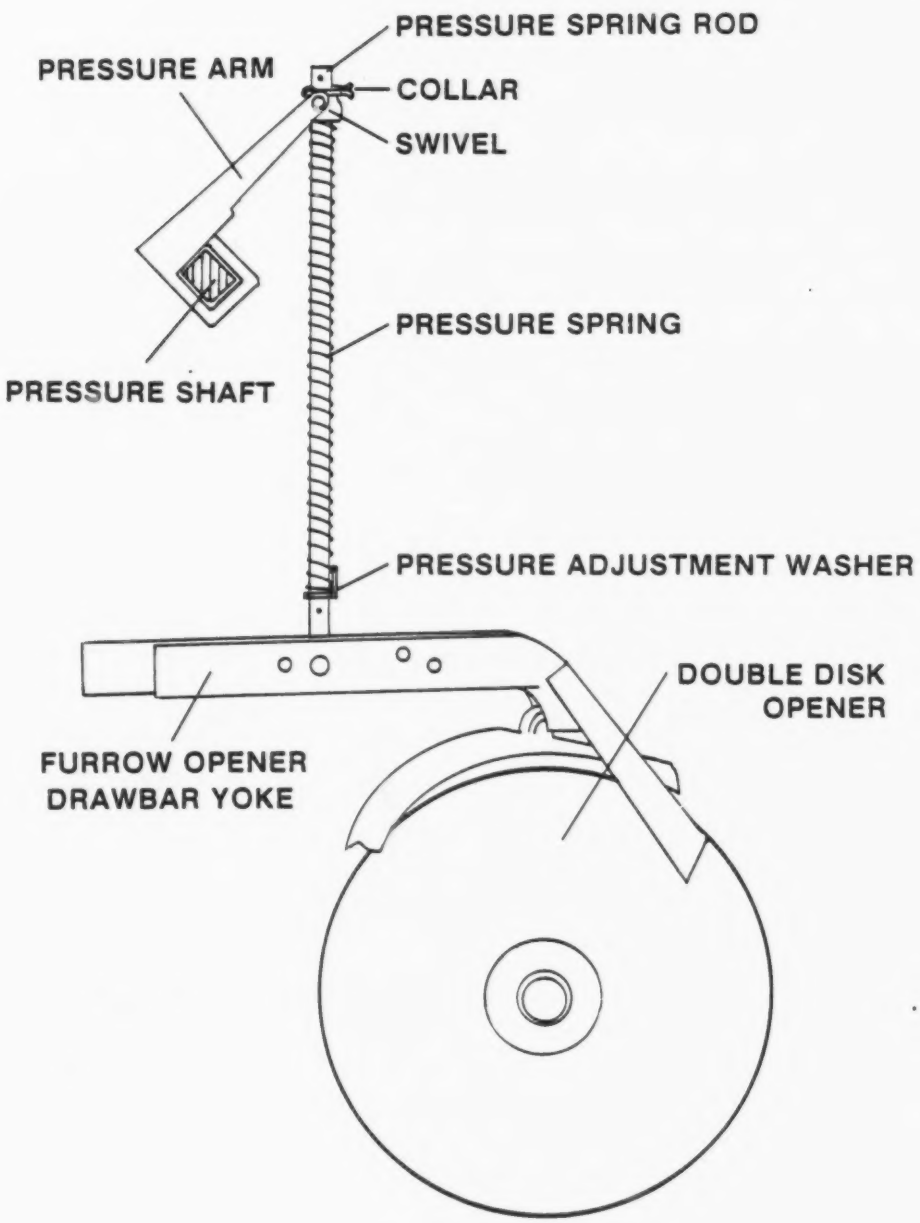
Marliss

On a level surface distances A and B should be equal.

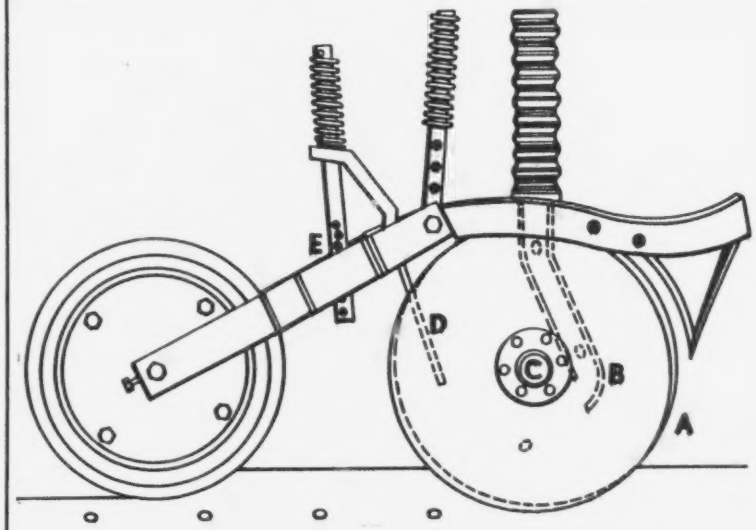
Level the drill by adjusting the hitch or using turnbuckle, depending upon the type of drill.

See the operator's manual.

PRESSURE SPRING ADJUSTMENT

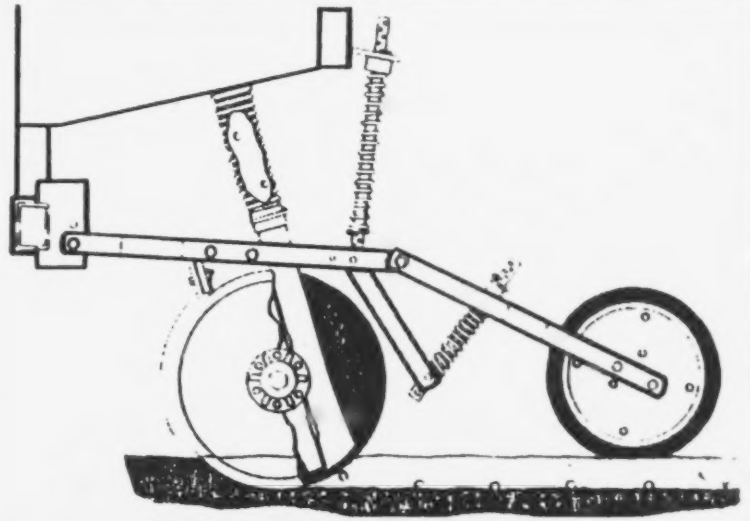


DEPTH LIMITING DEVICES

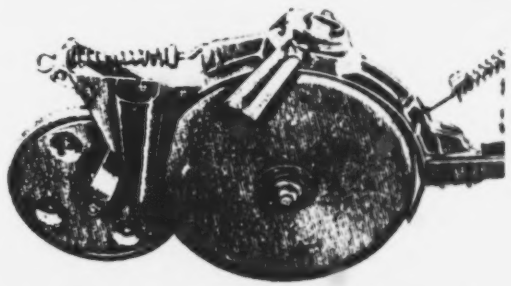


Depth Control Press Wheel

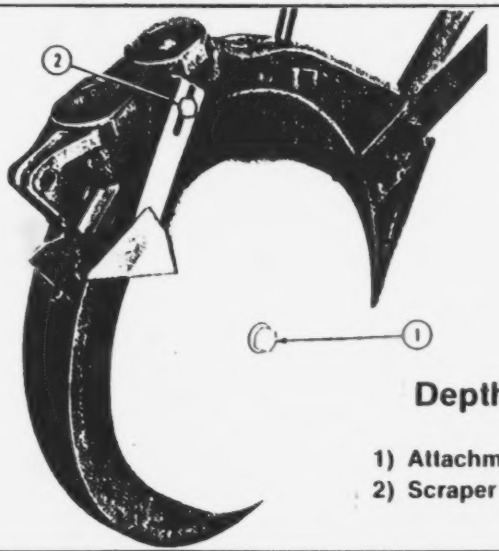
A) Offset disk blades
B) Seed tube
C) Sealed bearings
D) Inside scraper
E) Depth-gauging press wheel



Spring-loaded Firming Wheel
No depth control.



Lateral Depth Control Wheel

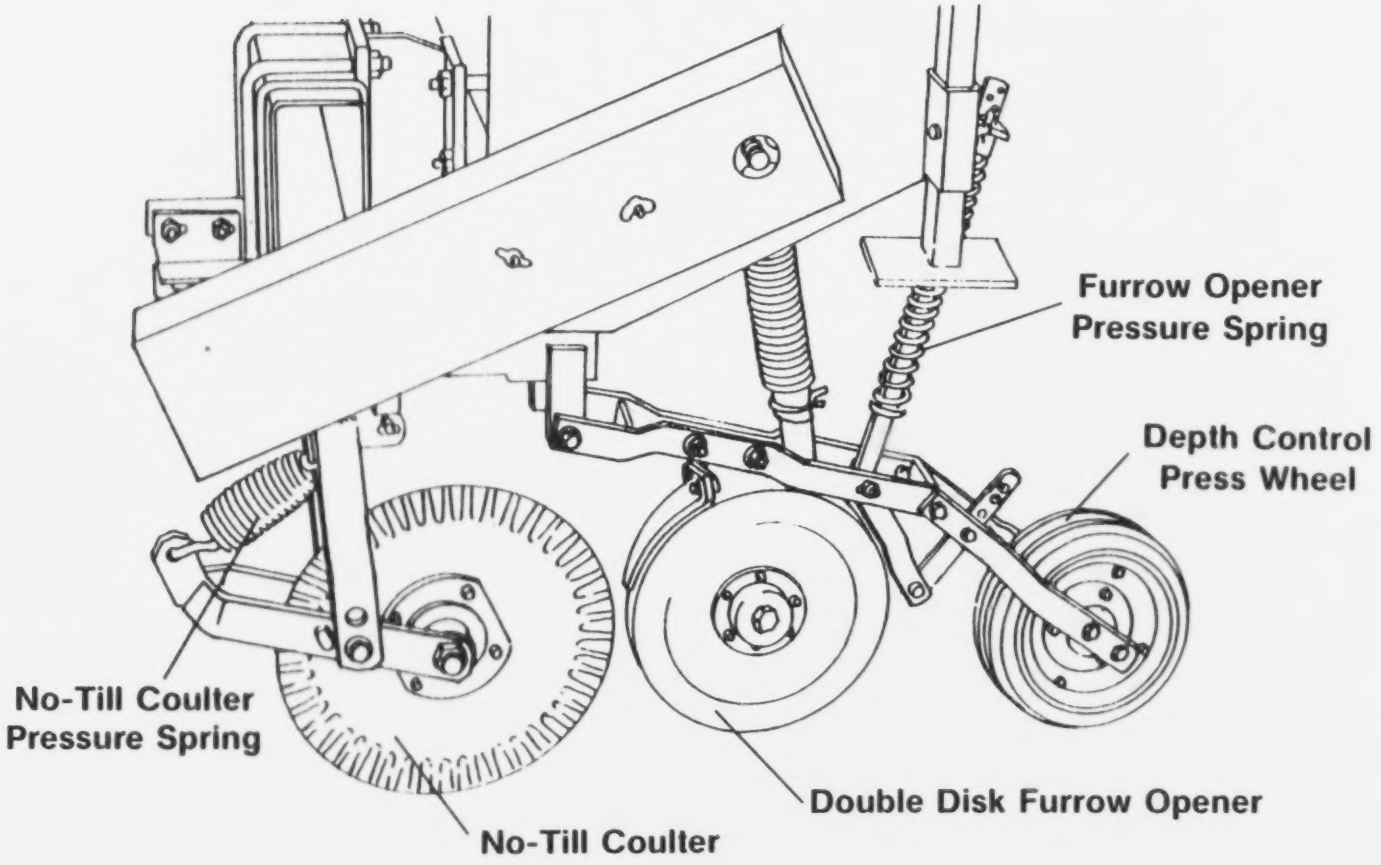


Depth Band

1) Attachment bolt
2) Scraper adjustment

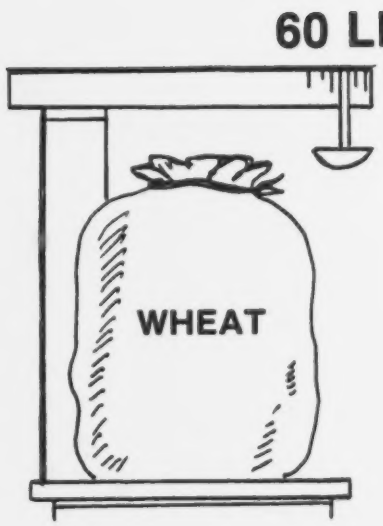
TM 35

MINIMUM TILL ATTACHMENT

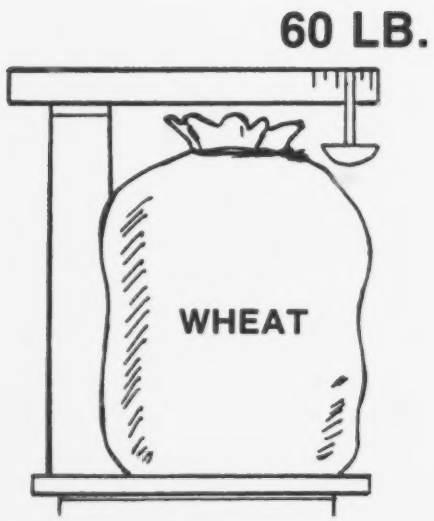


M & W Drill

Which Test Weight Has the Greater Volume?



High Test Weight



Low Test Weight

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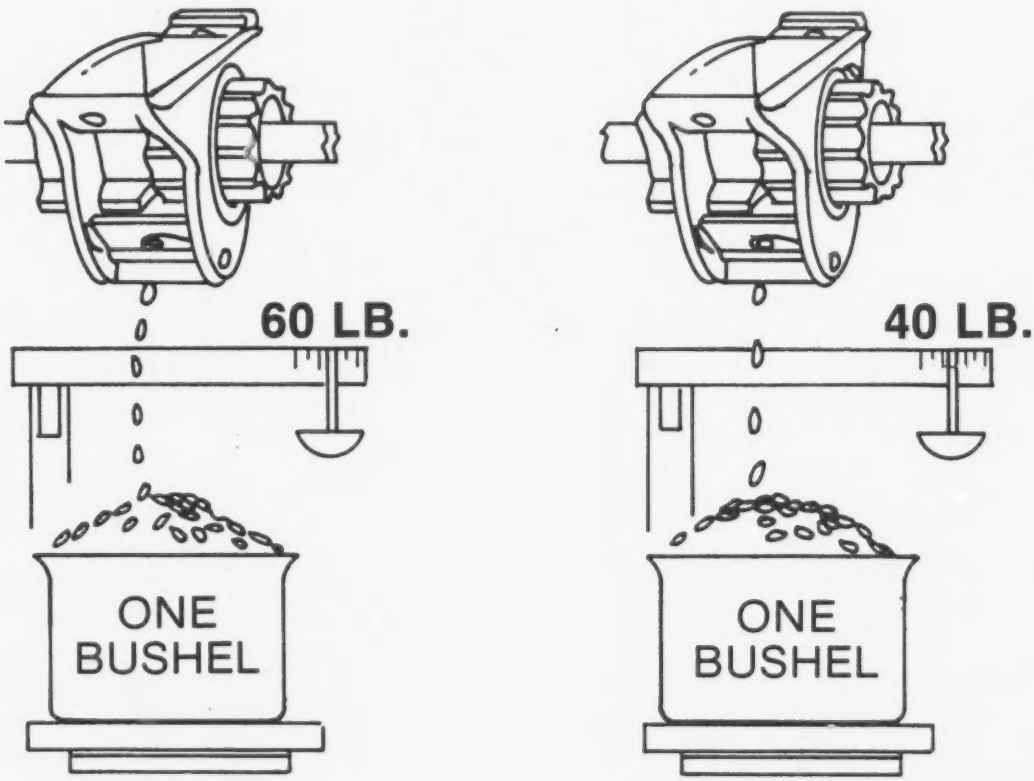
Importance of Checking Quantities Drilled



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PARTS OF THE GRAIN DRILL

NAME _____

Make and Model Drill: _____

The particular drill being studied may not have all of the parts or attachments listed on this form. Leave the section blank when the part is not on the drill being studied. Some drills will use designs different from others to accomplish a function such as a single disk, double disk, or shovel-type furrow openers. Describe the design of the drill being studied.

EXAMPLE

Name of Unit and Its Parts	Functions Performed by the Unit and Its Major Parts
ROW MARKER	GREAT PLAINS DRILL Row markers are raised and lowered hydraulically, marked to center line of tractor, and folded as they are raised. Breakaway bolts protect markers from damage. Used to reduce or eliminate gaps or overlaps between adjacent planted strips.

Name of Unit and Its Parts	CHECK TYPE or If Present	Functions Performed by the Unit and Its Major Parts
A. WHEELS AND DRIVE UNIT		
End wheel drive	_____	_____
Press wheel drive	_____	_____
Gauge wheel drive	_____	_____
Caster wheel drive	_____	_____
How is power transmitted to the feeding mechanisms?		_____ _____
B. HITCH UNIT AND MAIN FRAME		
Pull type	_____	_____
3-point hitch	_____	_____
Multiple hitch	_____	_____
No-till hitch	_____	_____
Secondary tillage hitch	_____	_____
Frame construction		_____
Regular seeding	_____	_____

(continued)

Name of Unit and Its Parts	CHECK TYPE or If Present	Functions Performed by the Unit and Its Major Parts
Frame construction (*continued*)		
Heavy duty no-till	____	
Means of transporting	____	
C. THE HOPPER UNIT		
1. Grain hopper	____	
a. Capacity	____	
b. Type of feeding unit		
• Fluted	____	
• Double-run	____	
c. Grain agitator	____	
d. Driving parts	____	
(diagram)		
2. Fertilizer hopper	____	
a. Capacity	____	
b. Type of feeding unit		
• Star wheel	____	
• Feed roll	____	
• Wire worm	____	
c. Driving parts	____	
(diagram)		
3. Grass seed attachment	____	
a. Location on drill	____	
b. Type of feeding unit		
• Fluted	____	
• ____ (Other)	____	

(continued)

Name of Unit and Its Parts	Function Performed by the Unit and Its Major Parts
3. Grass seed attachment (*continued*) CHECK TYPE or If Present	.....
c. Location of grass seed tubes	
• Band seed _____	
• Broadcast seed _____	
d. Driving parts _____	
(diagram)	
D. LIFTING UNIT	
1. Hand lever lift _____	
2. Mechanical _____	
3. Hydraulic _____	
E. CLUTCH	
F. FURROW OPENERS — DRAWBAR OR OPENER FRAME	
1. Disk	
a. Single _____	
b. Double _____	
c. Scrapers _____	
2. Shovel _____	
Kind of shovel _____	
3. Seed delivery boot _____	
4. Fertilizer spouts and fertilizer placement _____	
5. Seed and fertilizer delivery tubes _____	
6. Depth adjustment	
Pressure rods _____	
Depth bands _____	
Depth press wheel _____	
Lifting mechanism setting _____	

(continued)

Name of Unit and Its Parts	Function Performed by the Unit and Its Major Parts
G. SEED COVERING AND FIRMING	
1. End wheel drill (CHECK TYPE of If Present)	
a. Drag chain ____	
b. Tires ____	
c. Seed firming wheels ____	
d. Gang press wheels ____	
e. Depth press wheels ____	
2. Press wheel drill ____	
Style of press wheel ____	
H. ACREAGE COUNTER	
1. Mechanical ____	
2. Electronic ____	
I. ROW MARKER	
1. Mechanical lift ____	
2. Hydraulic lift ____	
• Rigid ____	
• Folding ____	
J. LUBRICATION SYSTEM	
Hand lubrication ____	
Multilube ____	
K. TILLAGE	
1. Minimum tillage attachment ____	
2. Tractor wheel track tillage ____	
3. Tillage devices pulled ahead of drill ____	

LUBRICATING THE GRAIN DRILL

Indicate the kind of lubrication required for the different parts of the grain drill. Follow the lubrication schedule in the operator's manual.

Drill Part	Sealed Bearings	Bearings Requiring Packing	Bearings Lubricated through Grease Fittings	Multi-Luber Unit	Surface Lubrication, Chains, Disks and Other Surfaces	Type of Lubricant	Lubrication Interval (D = daily A = annually)	Precautions to Take during Lubrication and Cleaning
Drive wheels								
Caster wheel(s)								
Gauge wheel(s)								
Press wheel(s)								
Feeding Unit Drives Grain								
Fertilizer								
Grass seed								
Drive chain								
Furrow openers								
Disk surface								
Hoppers Grain								
Fertilizer								
Grass seed								
Gear boxes								
Power lift								
Other								

F5
FORM 2

FORM 3

ADJUSTING THE GRAIN DRILL FOR RATE OF SEEDING AND FERTILIZER APPLICATION

Not all grain drills will have all of the parts listed. Cross out the parts not on your drill.

NAME _____

Make and model of drill _____

Tire size _____ Tire pressure _____

Crop being seeded _____ Date of seeding _____

Condition of seed _____

Condition of soil _____

Rate of seeding desired _____

Rate of fertilizer application _____

Rate of grass seeding _____

Part of Section	Recommended Setting	How Adjustment Is Made
GRAIN SEEDING		
• Fluted feed drills		
Fluted feed level position		
Feed gates		
Feed shaft speed		
• Double run feed drills		
Feed cup cover		
Feed gate lever		
Feed shaft speed		

(continued)

Part of Section	Recommended Setting	How Adjustment is Made
FERTILIZER APPLICATION		
• Feed rolls		
Drive shaft speed		
Gear box setting		
• Star wheel		
Fertilizer gate		
Fertilizer drive		
• Wire worm		
Fertilizer drive		
GRASS SEED		
Shift in or out		
Seed meter opening		
Grass seed drive speed		
Band seeding		
ROW CROP OR SKIP ROW SEEDING		
Grain metering		
Fertilizer metering		

Grain Drill Calibration - Laboratory Exercise *(continued)*

E. Determine the seeding width of your drill by one of the following methods:

1. Seeding width in feet = $\frac{\text{No. of furrow openers X width between openers in inches (see grain drill information)}}{12}$

OR

2. Seeding width in feet = Measured distance from outside furrow opener to the opposite outside furrow opener in inches + the width between furrow openers in inches ÷ 12

_____ Seeding width in feet = $\frac{\text{\# of openers X width \_\_\_\_\_ in. spacing}}{12}$

OR

_____ Seeding width in feet = $\frac{\text{in + width \_\_\_\_\_ in. spacing}}{12}$

The reason for adding the width between furrow openers to the total width measured from one outside furrow opener to the opposite outside furrow opener in #2 above is that the area seeded by one opener encompasses a width on either side of the opener equal to one-half of the opener spacing. See Figure 2 where we are using only four openers spaced 6 inches apart. The total width of the seeded area is 24 inches. However, if you measure from the outside of one furrow opener to the outside of the opposite furrow opener, you get only 18 inches. Thus you need to add the width between openers (6 inches) to get the total seeded width of 24 inches.

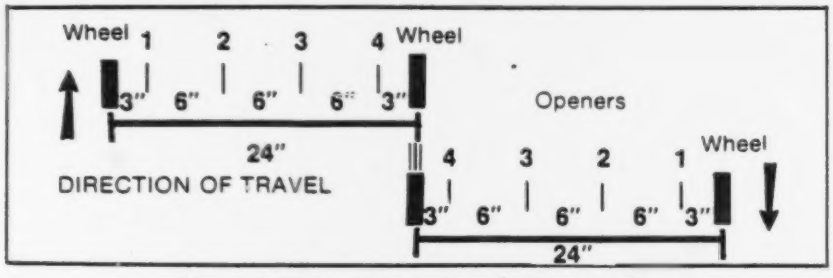


Figure 2. Measuring between furrow openers.

F Determine the distance the grain drill will have to travel to plant 1/20 acre. (Multiply 43,560 sq. ft./A by 1/20 A and divide by the seeding width in feet.)

Distance in feet = $\frac{43{,}560 \text{ X } 1/20}{\text{seeding width of drill in feet (see Step E)}}$

_____ Distance in feet = $\frac{43{,}560 \text{ X } 1/20}{\text{\_\_\_\_\_ seeding width of drill in feet}}$

G. Determine the number of wheel revolutions the drive wheel(s) need(s) to make to plant 1/20 acre.

Number of revolutions = $\frac{\text{Distance of travel in feet to plant 1/20 acre (see Step F)}}{\text{Circumference of the drive wheel (see Step D)}}$

_____ Number of revolutions = $\frac{\text{\_\_\_\_\_ feet of distance}}{\text{\_\_\_\_\_ feet of circumference}}$

(continued)

Grain Drill Calibration - Laboratory Exercise *(continued)*

H. Disconnect the seed tubes from the furrow openers and place a paper bag under each seed tube to collect the output.

I. With a paper bag under each seed tube, turn the drive wheel(s) the number of revolutions determined in Step G above. Make sure to turn the wheels in the same direction as they would turn when operating on the grain drill in the field.

J. Number the paper bags from left to right as you stand behind the drill. Weigh the amount of seed in each bag in ounces or grams and record below.

Opener Number	Weight	Opener Number	Weight
1	_____	13	_____
2	_____	14	_____
3	_____	15	_____
4	_____	16	_____
5	_____	17	_____
6	_____	18	_____
7	_____	19	_____
8	_____	20	_____
9	_____	21	_____
10	_____	22	_____
11	_____	23	_____
12	_____	24	_____
		TOTAL WEIGHT	_____

When measured in ounces:

$$\text{Total pounds per acre} = \frac{\text{Total weight in ounces}}{16} \times 20$$

OR

When measured in grams:

$$\text{Total pounds per acre} = \frac{\text{Total weight in grams}}{454} \times 20$$

$$\text{\_\_\_\_\_ Total pounds per acre} = \frac{\text{\_\_\_\_\_ Total weight}}{\text{16 oz. or 454 gm.}} \times 20$$

K. Plot the output of each seed metering device on the graph, Form 5. If uneven seed distribution is observed, what might be done to correct this situation?

See Form 5, *Grain Drill Feed Cup Distribution Graph.*

1. _____

2. _____

(continued)

Grain Drill Calibration - Laboratory Exercise *(continued)*

3. _____

4. _____

If one or more seed metering devices varies greatly from the others, the seed metering device(s) should be repaired or replaced.

L. _____ Seeding rate desired per acre (*Agronomy Handbook*)

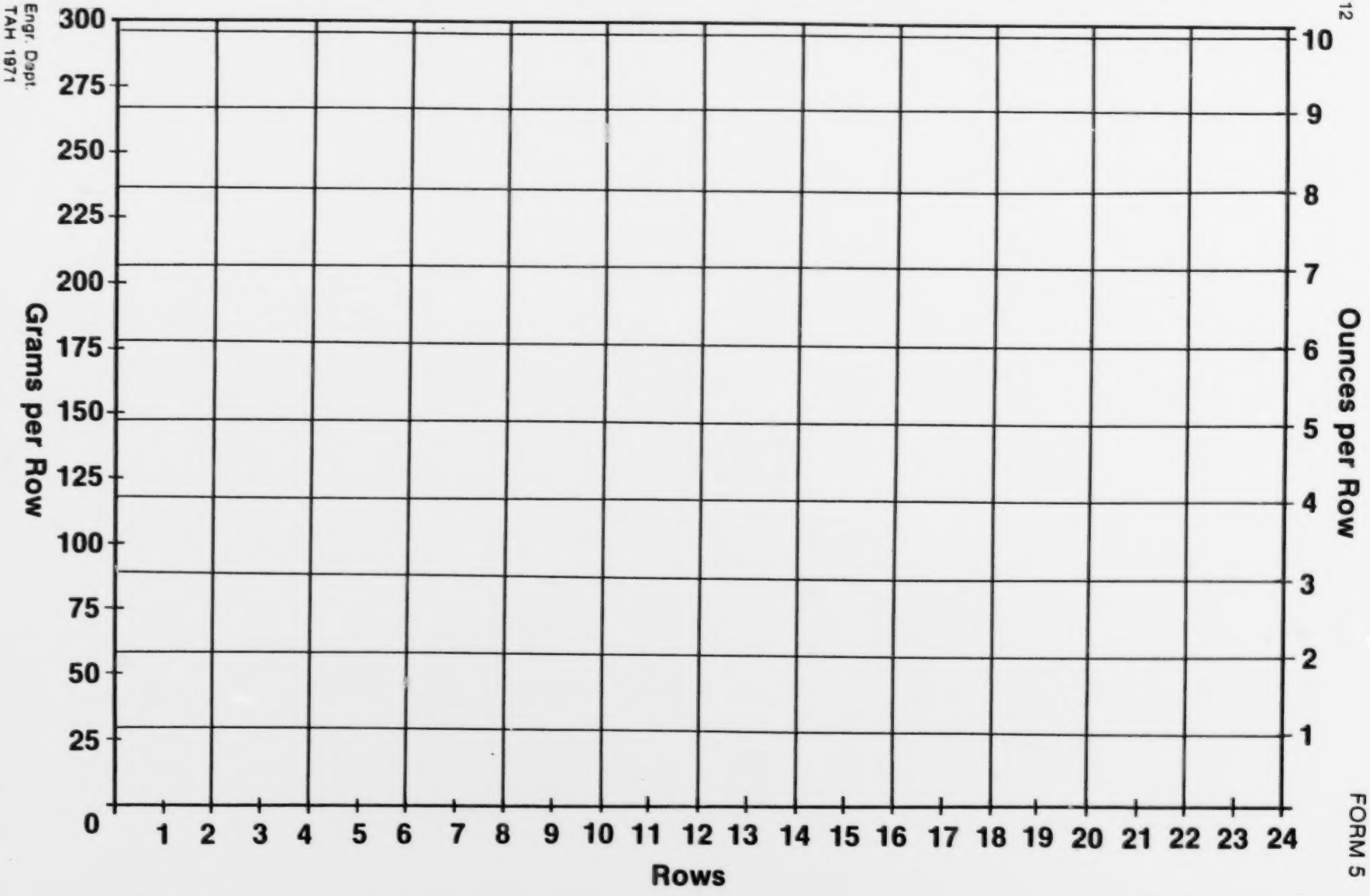
_____ Seeding rate obtained per acre (see Step J)

_____ Percentage of desired seeding rate

$$\text{Percentage of desired seeding rate} = \frac{\text{Seeding rate obtained per acre}}{\text{Seeding rate desired per acre}} \times 100$$

M. Make any needed adjustments to obtain the desired seeding rate per acre and then repeat Steps J through L.

GRAIN DRILL FEED CUP DISTRIBUTION GRAPH



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F12

FORM 5

FORM 6

FIELD EXERCISE

GRAIN DRILL CALIBRATION

NAME _____

Class _____ Date _____

Grain Drill Information:

Make _____ Model _____

Number of furrow openers _____ Width between furrow openers in inches _____

Field Calibration Procedure:

A. Using the operator's manual for the drill, set the seed metering device as indicated for the desired rate of seeding. For those questions that do not pertain to the type of drill you are using, answer "N.A." (not applicable).

_____ Feed gate position

_____ Seeding rate grain feed shifting lever position

_____ | _____ Gear drive sprocket combination
Drive gear / Driven gear

_____ Other settings needing to be selected

_____

B. Fill the seed hopper full and then pull the grain drill for a short distance to allow the seed to settle. Refill the hopper so that it is level-full.

C. Drill 1/20 of an acre.

$$\text{The distance to travel in feet} = \frac{43{,}560 \times 1/20}{\text{Seeding width of drill in feet*}}$$

$$\text{\_\_\_\_\_ Distance in feet} = \frac{43{,}560 \times 1/20}{\text{\_\_\_\_\_ Seeding width in feet}}$$

D. Carefully weigh the seed required to refill the seed hopper level-full. Multiply this amount by 20 to get seeding rate in pounds per acre.

E. _____ Seeding rate desired per acre

_____ Seeding rate obtained per acre

_____ Percentage of desired seeding rate

$$\text{Percentage of desired seeding rate} = \frac{\text{Seeding rate obtained per acre}}{\text{Seeding rate desired per acre}} \times 100$$

F. Make any needed adjustments to obtain the desired seeding rate per acre and repeat Steps C through E.

*See Form 4, Section E

(continued)

Grain Drill Calibration - Field Exercise *(continued)*

Soybeans

When using a grain drill to plant soybeans, you must be able to convert pounds per acre to seeds (plants) per acre. This is easily done by taking the seeding rate in pounds per acre times the number of seeds per pound. If the seed bag does not have the number of seeds per pound, you will need to determine the weight of a given number of seeds. For example, count out 500 seeds and weigh them; then take the seeding rate in pounds per acre times 500, divided by the weight of the 500 seeds. See the example which follows.

Example:

Assume: 500 seeds weigh 0.5 lb.

60 lb. per acre seeding rate

$$\text{Seeds per acre} = \frac{60 \times 500}{0.5} = 60{,}000$$

Grass Seed

Calibrating the grain drill for seeding of grass seed and applying of fertilizer is accomplished in the same manner as described previously. It simply involves collecting a measured amount of material over 1/20 acre and then multiplying this amount by 20 to obtain the rate in pounds per acre. It is very important that you calibrate the grain drill for these materials because they too are metered by volume, not by weight.

FORM 7

ADJUSTING THE GRAIN DRILL FOR DEPTH OF SEEDING

Not all grain drills will have all of the parts listed. Cross out the parts not on your drill.

NAME _____

Make and model of drill _____

Crop being seeded _____ Date of seeding _____

Condition of soil _____

Tillage practice _____

Seeding depth _____

Drill construction: ☐ Regular ☐ Heavy duty ☐ Provision for adding weight

Part or Section	Recommended Setting	How Adjustment is Made
• Drive wheels		
Height adjustment		
• Gauge wheel		
Raise or lower		
• Down pressure on furrow openers		
Pressure springs		
• Depth control		
Depth bands on furrow opener		
Depth control press wheel		
• Leveling		

(continued)-

Part or Section	Recommended Setting	How Adjustment Is Made
• Seed firming wheel		
Lateral depth control wheel at side of openers		
• Lifting mechanism		
Hand lift lever		
Mechanical lift		
Hydraulic lift		
• No-till coulters		
Type		
Depth adjustment		
Weight brackets		

FORM 8

CHECKING THE GRAIN DRILL PERFORMANCE IN THE FIELD

NAME _____

Make and model of drill _____

Crop being seeded _____ Date of seeding _____

Desired depth of seeding _____

Desired rate of seeding _____

Condition of soil and tillage practice _____

What to Check	Condition Found
Seeding depth and uniformity of depth	
Seed covering and firming of soil	
Rate of seeding seeds per foot of row	
No-till coulter	
Grass seed and fertilizer feeding tubes	

Conclusion: If the job of seeding is not satisfactory, what changes do you recommend?

FORM 9

TROUBLE-SHOOTING GRAIN DRILLS

NAME _____

Class _____ Date _____

Grain Drill Information:

Make _____ Model _____

Type of drill _____

Conditions under Which Drill is Being Used:

Crop being seeded _____ Rate per acre _____

Condition of seed:

- Clean or dirty _____
- Treatment applied _____
- Test weight _____

Grass seed:

- Crop _____ Rate per acre _____
- Condition of seed _____

Fertilizer application:

- Rate per acre _____
- Condition of fertilizer _____

Condition of seedbed:

- Conventional till _____
- Minimum till _____
- No-till _____

(continued)

PROBLEMS ENCOUNTERED

Refer to operator's manual for specific adjustments and fill in the last column with the page number where the possible solution is described. Use "N.A." when not applicable.

DRILLING GRAIN

Possible Cause	Suggested Solution	Page No.
Problem: ***Furrow opening disks not rotating***		
1. Trash or mud build-up on disks and scrapers.	1. Clean trash and mud from the furrow opener and readjust scrapers if needed.	
2. Disk scrapers too tight.	2. Adjust scrapers.	
3. Pressure rod spring too tight or too loose.	3. Adjust pressure rod spring tension.	
4. Disk bearings worn or frozen.	4. Replace disk bearings.	
5. Disks assembled wrong.	5. Check for correct disk assembly.	
6. Drill hitched too high in front so pressure is on boot rather than disk.	6. Hitch drill level.	
7. Furrow opener drawbar damaged.	7. Replace furrow opener drawbar. Do not make sharp turns without raising furrow openers.	
8. Drills with height adjustment on wheels riding too high.	8. Lower drill on wheels so disks will be in ground.	
Problem: ***Plugging of grain tubes and openers***		
1. Drill not hitched level.	1. Hitch drill properly.	
2. Allowing drill to roll back when stopping or backing with openers in ground filling bottom of boot with dirt.	2. Raise furrow openers before stopping or backing.	
3. Landside on single disk openers improperly adjusted.	3. Adjust landside.	
4. Trashy seed.	4. Use clean seed.	
5. Drill with combined grain and fertilizer delivery tubes has fertilizer build-up in delivery tube due to moisture.	5. Use clean dry fertilizer or use separate delivery tubes.	
6. Convolute tube (rubber coiled seed delivery tube) has rib collapsed inside opener boot.	6. Install seed tube correctly in boot without collapsed rib.	
Problem: ***Excessive wear on bottom of boot or poor penetration with single disk opener***		
1. Boot adjusted too low.	1. Adjust boot.	
Problem: ***Fluted feed lever difficult to shift***		
1. Dirt on exposed flute.	1. Remove dirt.	
2. Binding of grain feed shaft.	2. Rock feed shaft with a wrench. Loosen bound parts with solvent.	

(continued)

Possible Cause	Suggested Solution	Page No.
3. Feed cups not in line with feed shaft.	3. Realign feed cups.	
Problem: ***Fluted feed lever does not stay in place***		
1. Damaged shifting lever and assembly.	1. Replace entire assembly.	
Problem: ***Different quantities of grain sown by individual feeds***		
1. Feed gates set for different size openings.	1. Set all feed gates the same.	
2. Fluted cylinder seed meters opened unevenly.	2. Check each metering unit for proper opening and readjust if necessary.	
3. Too much trash in seed.	3. Clean the seed.	
4. Spring pressure on cleanout arm improperly set.	4. Reset spring pressure.	
5. Not enough seed in hoppers.	5. Add more seed.	
6. Seed bridging in box due to unclean seed, inoculation treatment, or dampness.	6. Use agitators. Clean seed if trash is a problem.	
7. Grain runs, conductors, tubes, or openers clogged.	7. Clear obstruction.	
Problem: ***Bunching and skipping***		
1. Improper procedure for setting shift lever.	1. Follow correct procedures.	
2. Seed tubes sag causing seed to accumulate.	2. Install seed tubes properly.	
3. Double disk opener not turning smoothly.	3. Loosen scrapers, adjust disks.	
4. Loose or swinging tractor drawbar.	4. Lock tractor drawbar to prevent swinging.	
5. Improper adjustment of furrow openers resulting in openers not penetrating low spots or bouncing over rough ground.	5. Adjust opener pressure rods.	
6. Stopping drill in field.	6. Stop only at ends of field unless necessary to stop at other places.	
7. Slow grain drive shaft sprocket ratio.	7. Use faster ratio and reduce seeder opening.	
8. Ground speed too slow.	8. Drive at recommended speed.	
9. Feed cup bottoms not set for type of seed being sown.	9. Properly set seed cups.	
Problem: ***Planting too deep***		
1. Excessive down pressure.	1. Reduce spring pressure on the pressure rod.	
2. Drill too low.	2. Lower wheels on drill frame to raise drill. Attach three-point hitch properly.	
3. Press wheel adjustment too high.	3. Adjust press wheel linkage.	

(continued)

Possible Cause	Suggested Solution	Page No.
4. Seed bed too loose.	4. Lower clip pin setting in depth strap or pressure rod.	
5. Drill not leveled.	5. Level drill. In some cases install gauge wheels.	
Problem: ***Planting too shallow***		
1. Insufficient down pressure.	1. Increase spring pressure on the pressure rod.	
2. Seed bed not prepared or ground too hard.	2. Manage soil to reduce compaction.	
3. Depth control wheel adjusted too low.	3. Raise depth control wheel.	
4. Ground speed too fast, causing drill to ride out of ground.	4. Operate at recommended speed.	
5. No-till attachment too light to penetrate soil.	5. Add weight to the unit.	
Problem: ***Left and right side planting of different rates***		
1. Using tires of different size on end wheels or gauge wheels.	1. Use tires of same size.	
2. Tire pressure different.	2. Use recommended tire pressure.	
3. Seeder setting different.	3. Use same seeder setting on each side of drill.	
4. Different sprocket ratios.	4. Use recommended sprocket setting on each side of drill.	
Problem: ***Seeds not covered***		
1. Planting too shallow.	1. Increase planting depth adjustment.	
2. Planting too wet.	2. Check soil moisture.	
3. Planting too fast.	3. Plant at recommended speed.	
Problem: ***Actual seeding different from desired or does not agree with chart***		
1. Wrong tire size or inflation.	1. Use recommended tire size and inflation.	
2. Using heavier or lighter seed than that shown in chart.	2. Disregard seed charts and calibrate drill for seed being sown.	
3. Seed texture and size not the same as that shown in chart.	3. Disregard seed charts and calibrate drill for seed being sown.	
4. Feed cups not aligned with fluted roll at zero setting.	4. Align feed cups.	
5. Wrong drive sprocket.	5. Install correct sprocket.	

(continued)

Possible Cause	Suggested Solution	Page No.
6. Incorrect feed cup bottom setting.	6. Set feed cup bottom in correct notch.	
7. Seed bridging in grain box.	7. Install agitator.	
8. Seed treatment causing build-up in seed cup, which will affect rate of seeding and may cause breakage.	8. Inspect and clean seed cups regularly when treated seed is used.	
9. Improper shift lever setting.	9. Correct shift lever setting.	
Problem: ***Excessive seed cracking***		
1. Improper feed gate latch position.	1. Adjust for seed being sown.	
2. Flute feed opening too small.	2. Slow grain drive shaft speed and open flutes.	
DISTRIBUTING GRASS SEED		
Problem: ***Irregular distribution of grass seed***		
1. Seed clogging the tubes.	1. Adjust tubes.	
2. Seed tubes clogged with trash.	2. Remove tubes and clean.	
Problem: ***Different quantities of grass seed sown by individual feeds***		
1. Sowing light chaffy seed.	1. Mix seed with heavier seed or other material such as cracked corn.	
Problem: ***Actual seeding different from desired or does not agree with chart***		
1. Wrong grass feed drive shaft speed adjustment.	1. Change the sprocket or gear combination to achieve desired speed.	
2. Wrong tire size or inflation.	2. Use recommended tire size and inflation.	
3. Seed weight per bushel (density) and texture different from seed used in table.	3. Disregard seed chart and calibrate drill for seed being sown.	
4. Grass seed metering devices improperly adjusted.	4. Set correct adjustment.	
5. Improper shift lever setting.	5. Correct shift lever setting.	
DRILLING FERTILIZER		
Problem: ***Clogging of fertilizer feed tubes***		

(continued)

Possible Cause	Suggested Solution	Page No.
1. Allowing drill to roll back when stopping or backing with openers in ground filling bottom of boot with dirt.	1. Raise furrow openers before stopping or backing.	
2. Convolute tube (rubber coiled fertilizer delivery tube) has rib collapsed inside opener boot.	2. Install fertilizer tube correctly in boot without collapsed rib.	
Problem: ***Flow of fertilizer stops***		
1. Fertilizer feeds become "frozen" with caked fertilizer causing broken shear pins.	1. Clean caked fertilizer from fertilizer feeds and install new shear pins.	
2. Broken drive chain caused by caked fertilizer in fertilizer feeds.	2. Clean caked fertilizer from fertilizer feeds. Check free movement of shaft and replace chain.	
3. Crown gear in case not touching pinion.	3. Correct the conditions in the gear box.	
4. Fertilizer feed shaft or sleeve worn in rounded condition.	4. Replace worn part.	
Problem: ***Fertilizer spills out of feeds***		
1. Baffles installed incorrectly.	1. Install baffles as shown in operator's manual.	
Problem: ***Fertilizer distribution erratic or incorrect***		
1. Using wrong fertilizer drive.	1. Check sprocket, gear, or gear box setting.	
2. Have not checked quantity of fertilizer drilled.	2. Check quantity of fertilizer drilled and calibrate the rate of fertilizer application.	
3. Fertilizer density (wt./cu. ft.) is different from standard used in making charts.	3. Determine fertilizer density and calibrate for desired rate of application.	
4. Feed wheel installed incorrectly.	4. Install feed wheel correctly.	
5. Baffles bent or installed incorrectly.	5. Straighten baffles; install correctly.	
6. Drop bottoms loose, or clearance between back panel and star wheel too great.	6. Shorten clamps on drop bottom until gap between back panel and star wheel is correct.	
7. Fertilizer feed units set incorrectly.	7. Check with operator's manual for recommended settings.	

MECHANICAL PROBLEMS

Problem: ***Drive chain runs off sprocket or breaks***		
1. Line of chain travel not straight.	1. Realign to straighten chain travel from sprocket to sprocket.	

(continued)

Possible Cause	Suggested Solution	Page No.
2. Object caught in sprocket.	2. Remove object.	
3. Chain too loose.	3. Adjust idlers or remove links.	
4. Sprockets and/or chain worn.	4. Replace sprockets and/or chain.	
Problem: ***Drill riding out of ground***		
1. Excessive speed pulls drill out of ground.	1. Run at recommended speed.	
Problem: ***Excessive wear on holes in press wheel straps***		
1. Press wheels bouncing.	1. Add more pressure.	
Problem: ***Drive shafts (grain, grass and/or fertilizer) difficult to turn or frozen***		
1. Dirt (soil, seed, trash, or fertilizer) caked in feed metering devices	1. Clean using solvent or water or air pressure as needed. Do not get solvent on feeder tubes. Do not get solvent or water in boot. Lubricate parts with light oil.	
2. Bearing failure.	2. Replace bearing.	
3. Feed metering devices not in proper adjustment (for grain, grass, and/or fertilizer).	3. Adjust feed metering devices according to operator's manual (for grain, grass, and/or fertilizer).	
Problem: ***Acremeter reading inaccurate***		
1. Improper tire size or inflation.	1. Use recommended tire size and inflation.	
2. Double tracking or skipping space between drill runs.	2. Drive carefully or use marker.	
3. Turning at end of drill run without raising openers.	3. Raise furrow openers before turning.	
4. Acremeter not set correctly.	4. Adjust acremeter.	
5. Field contains more or less land than assumed.	5. Remeasure land.	
Problem: ***Clutch slips or will not engage***		
1. Improper adjustment or assembly.	1. Adjust and/or assemble correctly.	
2. Worn or broken parts.	2. Replace worn or broken parts.	
Problem: ***Clutch will not disengage***		
1. Improper adjustment or assembly.	1. Adjust and/or assemble correctly.	